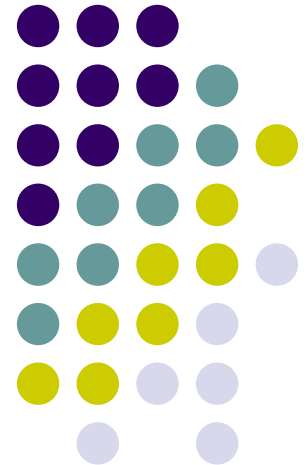


# The Viability of Commissioning in New School Construction

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Association of Energy Engineers  
San Antonio/Austin Chapter  
O'Connor High School  
Helotes, Texas  
July 24, 2007



# Your Presenters



- Frank Thomas, CEM, CDSM
  - Facilities Energy Manager
  - Northside Independent School District
  
- Michael Martin, CEM
  - Senior Research Engineer
  - Texas Engineering Experiment Station



# The Viability of Commissioning in New School Construction

- Overview
  - Elements of Commissioning
  - Benefits of Commissioning
  - Potential of Commissioning
- Basis
  - A Three Year Study and Application of Commissioning in Elementary School Construction

# Elements of Commissioning



- Background of Commissioning (Cx)
- What is Commissioning ?
- The NISD Study of Commissioning

# Background of Commissioning



- **History**

- Born of a need for more sustainable, maintenance friendly, and operationally efficient facilities
- Commissioning is now a key component of LEED certification at all levels

- **Key Players**

- DOE and USGBC
- ASHRAE
- AIA and AEE
- Many More .....

# What is Commissioning?



- The systematic application of design review and assistance coupled with construction monitoring, detailed field testing and verification and operational effectiveness validation and documentation
- Performed by an appropriately trained and duly appointed Commissioning Authority as a full member of the design team
- Let's Break this Down ...

# What is Commissioning?



- The systematic application of design review and assistance...
  - Commissioning Authority (CxA) provides design insight from multiple lessons learned on similar projects
  - CxA provides product options and opinions for various equipment items to support the Owner's desires and the design team professional's design intent
  - CxA provides the Commissioning Technical Specification to be included in the Construction Contract
  - CxA provides documentation of the entire design process and offers feedback for possible improvements

# What is Commissioning?

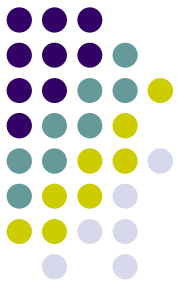


- ... coupled with construction monitoring,
  - Commissioning Authority provides on site monitoring throughout the construction process
    - This variable dependent upon Owner's needs and desires
    - May coordinate with General Contractor (GC) on scheduling issues to avoid "trade-stacking"
    - May act as a conduit for communications amongst all parties depending on level of commissioning
    - Helps facilitate at construction progress meetings

# What is Commissioning?



- ... detailed field testing and verification,
  - Field Installation Verification
  - Operational Performance Testing
  - Functional Performance Testing
  - Over-the-shoulder Test and Balance verification



# What is Commissioning?

- ... and operational effectiveness validation and documentation
  - Point to Point Controls Validation
  - Total Systems Effectiveness Validation
  - Complete Documentation
  - Insure ALL Training has been Conducted



# What is Commissioning?

- Performed by an appropriately trained and duly appointed Commissioning Authority as a full member of the design team
  - Select Cx Authority Carefully
    - National Environmental Balancing Bureau (NEBB) or other appropriate certification
  - Total Commitment and Communication Required by Owner, General Contractor and All Design Team Members

# The NISD Study of Commissioning



- **Background**

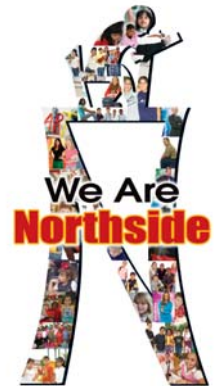
- Texas State Energy Conservation Office (SECO) and NISD interested in determining validity of Cx in New School Construction
  - Sustainability Issues
  - Utility Cost Issues
  - Energy Consumption Issues
  - Facility Effectiveness Issues
  - Maintenance Issues

# The NISD Study of Commissioning



- **Key Players**

- Texas State Energy Conservation Office (SECO)
  - Provided Funding for the Study
- Northside Independent School District (NISD)
  - Facilities Construction Department
  - Engineering Services Department
  - Maintenance and Operations Department
  - Energy Management Department
- The Design Team
  - PBK Architects
  - Silber and Associates
- Texas Engineering Experiment Station (TEES)
  - Brooks Energy Sustainability Laboratory (BESL)
- Engineering Economics, Inc. (EEI)
  - The Commissioning Authority



# The NISD Study of Commissioning



- Why Study?
  - To Prove or Disprove the Validity of Commissioning in New School Construction
  - If valid, to develop and share the benefits and potentials of Commissioning with Design Professionals and School Districts throughout Texas ...
  - So what are the benefits?

# Benefits of Commissioning



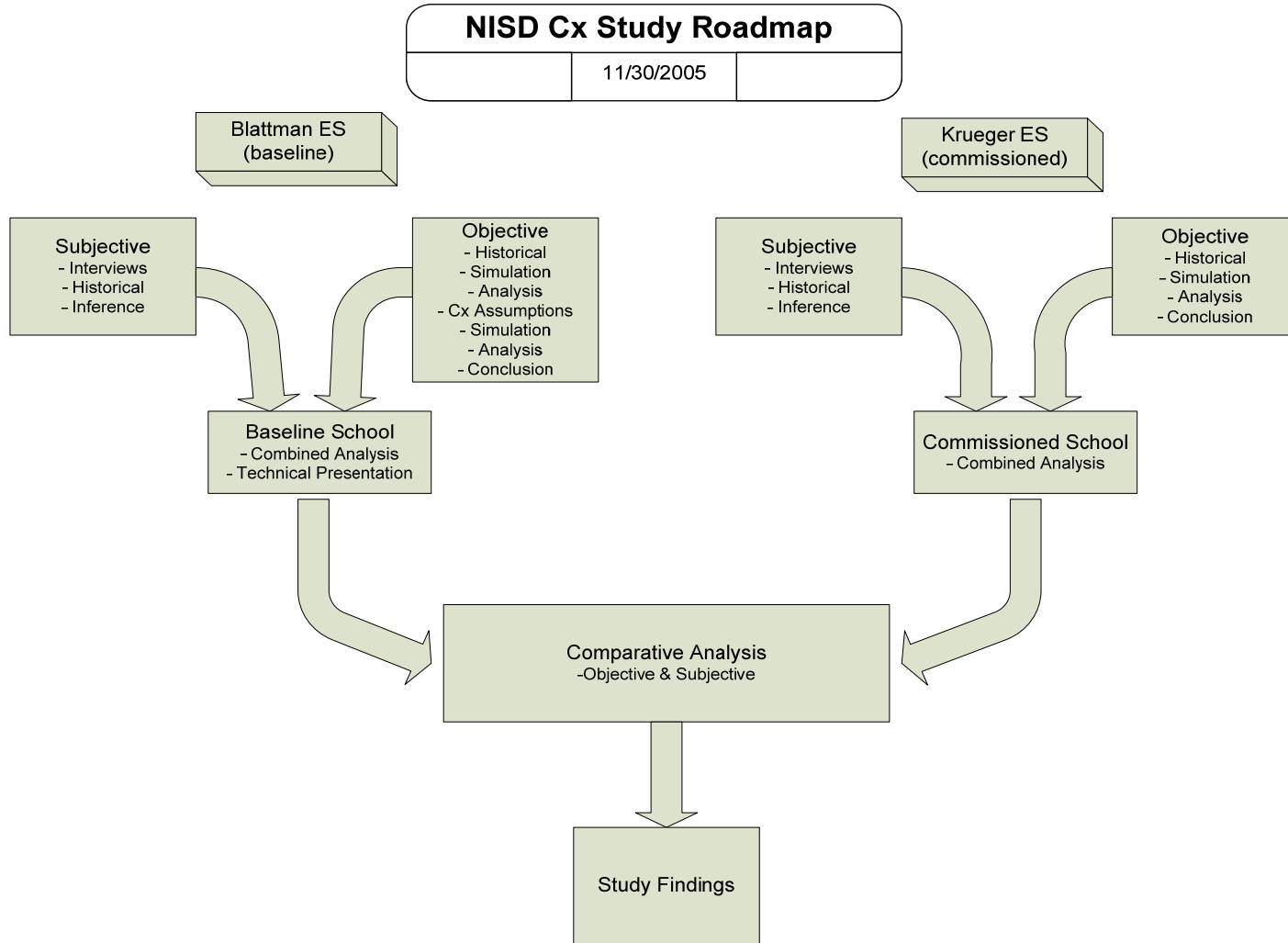
- Information is Out There
  - CX = Sustainability...Identify Sources
- What Makes the NISD Study Unique?
  - Study Methodology
    - Decision on Key Metrics
  - Study Campuses
  - Restricted MEP Focus

# Benefits of Commissioning



- Study Methodology
  - Develop appropriate metrics for comparison
    - RFI's, Change orders, Punch list, Project timeline, Occupant reported problems, Warranty service, Work orders, Energy use
  - Data gathering
    - Historical vs. real time tracking
    - Utility cost and consumption
    - Quantitative vs. Qualitative

# Benefits of Commissioning



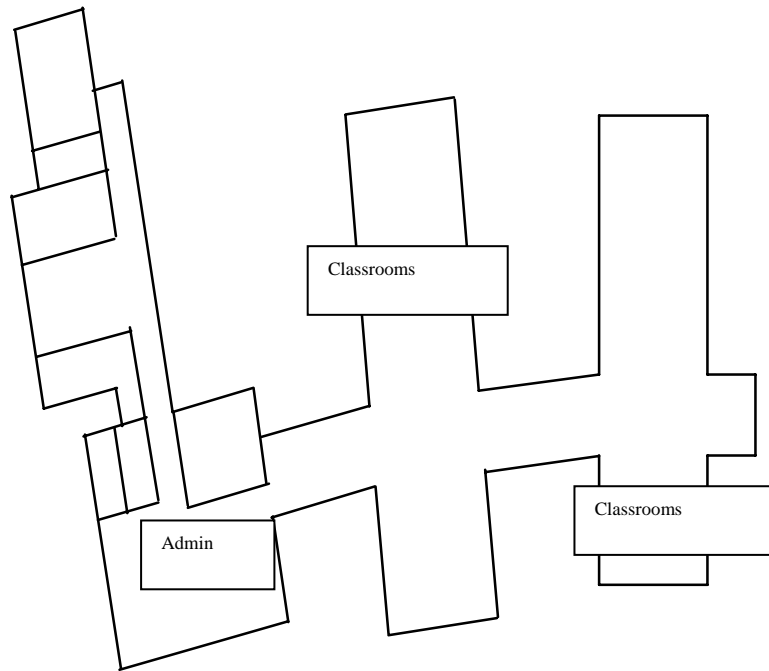
# Benefits of Commissioning



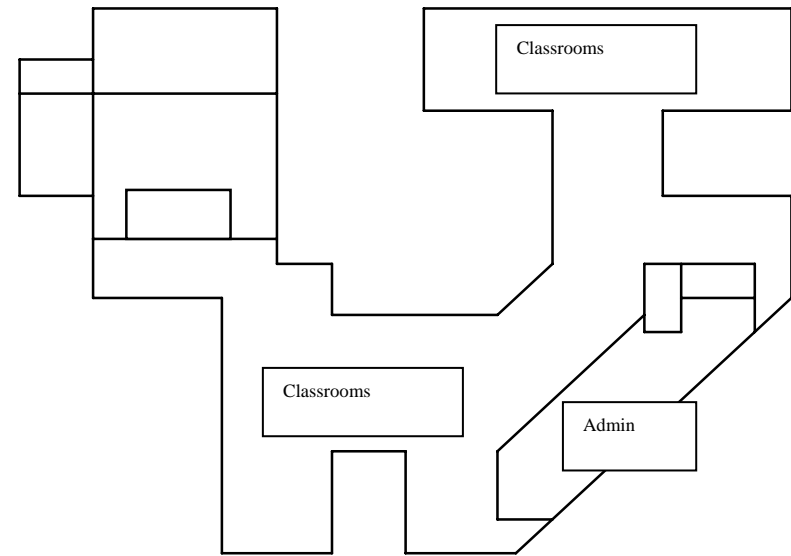
- Study campuses
  - Variations and similarities

<b>Characteristic</b>	<b>Baseline School</b>	<b>Commissioned School</b>
<i>floor area</i>	86,000 sqft	100,800 sqft
<i>number of students</i>	660	800
<i>expected construction cost</i>	\$10,400,000	\$11,200,000
<i>year design was started</i>	2001	2003
<i>year of first occupancy</i>	2003	2005
<i>type of mechanical system</i>	air-cooled chillers, air-handling units, fan-powered boxes,	same type of systems
<i>air conditioned gymnasium</i>	initially designed to be ventilated, conditioning added as change order	air conditioned
<i>energy code</i>	not applicable	IECC 2000
<i>architect</i>	first new school for this district	same architect
<i>general contractor</i>	well established with district	worked previously in district
<i>major subcontractors</i>	well established with district	well established with district

# Benefits of Commissioning



**Blattman**



**Krueger**

# Benefits of Commissioning



- Focus on Mechanical/Electrical/Plumbing (MEP) aspects of the facilities
  - Initially based on energy related concerns
  - Consensus of affected parties
  - Restricted scope based on study limitations
    - Taking small steps first – reality check
    - Area with the greatest impact/concern

# Benefits of Commissioning



- Metric – Request for Information (RFI)
  - Number of MEP related RFI's  
*Baseline 22 vs. Commissioned 24*
  - Average number of days in review  
*Baseline 9 vs. Commissioned 13*
- Analysis of RFI Metric

# Benefits of Commissioning



- Metric – Change Orders
  - Number of MEP related Change Orders  
*Baseline 37 vs. Commissioned 14*
  - Cost of MEP related Change Orders\*  
*Baseline 0.9% vs. Commissioned 0.4%*
- Analysis of Change Order Metric

\* As a % function of construction cost

# Benefits of Commissioning



- Metric – Building Punch List
  - Number of MEP related Punch List items\*  
*Baseline 2.7 vs. Commissioned 1.3*
- Analysis of Punch List Metric

\* Average number of items per room

# Benefits of Commissioning



- Metric – Design/Construction Schedule
  - Variance in Design Phase\*  
*Baseline -5.5% vs. Commissioned 11.4%*
  - Variance in Construction Phase\*\*  
*Baseline 26.7% vs. Commissioned 11.9%*

- Discussion of Schedule Metric

\* Difference between expected and actual duration in days

\*\* Difference between planned and actual duration in days

# Benefits of Commissioning



- Metric – Design/Construction Cost
  - Variance in Design Cost  
*Baseline -4.2% vs. Commissioned 7.1%*
  - Variance in Construction Bid Cost  
*Baseline -4.7% vs. Commissioned 6.1%*
  - Variance in Bid and Actual Cost  
*Baseline 1.2% vs. Commissioned 3.4%*
- Discussion of Project Cost Metric

# Benefits of Commissioning



- Metric – Post Occupancy Evaluation
  - Number of MEP issues identified  
*Baseline 5 vs. Commissioned 5*
- Comments on Post Occupancy Metric

# Benefits of Commissioning



- Metric – Maintenance Work Orders

- Number of work orders\*

*Baseline 122 vs. Commissioned 116*

- Cost of work orders\*

*Baseline \$9,300.00 vs. Commissioned \$6,900.00*

- Comments on Work Order Metric

\* based on first six months of operation; includes warranty issues; includes labor and materials

# Benefits of Commissioning



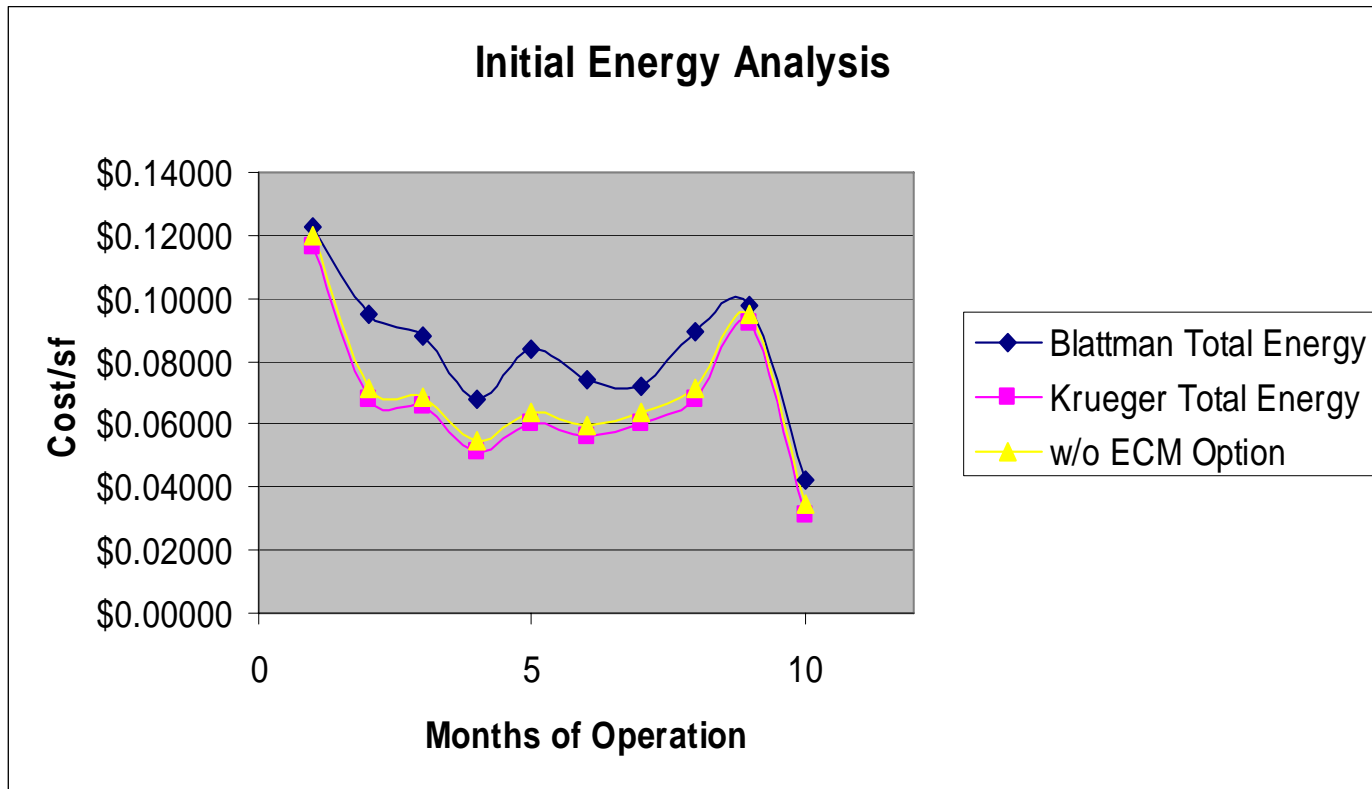
- Metric – Energy reduction\*
  - Approximately \$0.016/sf/month
  - Trend analysis for both facilities indicates
    - Active involvement of District Energy Managers
    - EMCS maintaining comfort control within prescribed limits
  - Savings generated by multiple sources
- Comments on Energy Metric

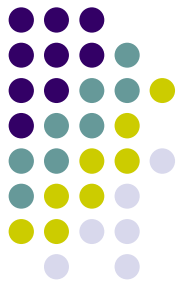
\*normalized and based on 10 month school year

# Benefits of Commissioning



- Metric – Energy Use





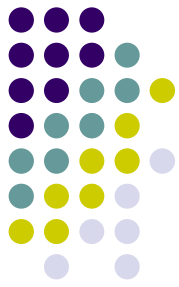
# Benefits of Commissioning

## Recap of Results

Metric	Description	Blattman ES	Krueger ES
<i>RFIs</i>	Number of MEP-Related RFIs (per 10,000 sqft)	2.6	2.4
	Average Number of Days in Review	9	13
<i>Change Orders</i>	Number of MEP-Related Change Orders (per 10,000 sqft)	4.4	1.4
	Cost of MEP-Related Change Orders (% of Construction Cost)	0.9%	0.4%
<i>Punchlist</i>	Average Number of MEP-Related Punchlist Issues per Room	2.7	1.3
<i>Schedule</i>	Difference between Expected and Actual Duration of Design Phase	-5.5%	11.4%
	Difference between Planned and Actual Duration of Construction Phase	26.7%	11.9%
<i>Cost</i>	Difference between Expected and Actual Design Cost	-4.2%	7.1%
	Difference between Expected and Bid Construction Cost	-4.7%	6.1%
	Difference between Bid and Actual Cost	1.2%	3.4%
<i>Post-Occ Eval.</i>	Number of Significant MEP-Related Issues Identified in First Year	5	* 5 *
<i>Work Orders</i>	Number of MEP-Related Work Orders in First Year (per 10,000 sqft)	14.5	* 11.5 *
	Cost of MEP-Related Work Orders in First Year (per 10,000 sqft)	\$1,079.00	* \$694.00 *
<i>Energy Use</i>	Electricity (annual kBtu/sqft)	42.5	34.2
	Natural Gas (annual kBtu/sqft)	14.5	9.0

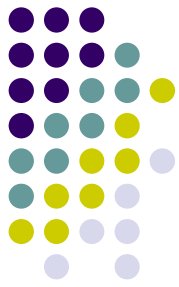
\* = first six months operation

# Benefits of Commissioning



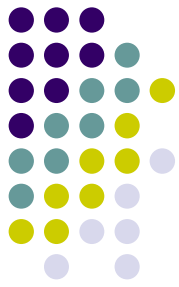
- But remember – this was a restricted study...not statistically significant
- So what is the Potential of Commissioning in New School Construction?
- Let's Take a Look...

# Potential of Commissioning



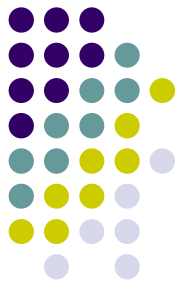
- Whole New Building Commissioning
  - Building Site Selection and Preparation
  - Building Envelope and Orientation
  - Building Systems beyond MEP
  - Simulation Application

# Potential of Commissioning



- Retro-Commissioning
  - Equipment Upgrades
  - Indoor Air Quality Issues
  - Decrease Energy Consumption and Utility Bills
  - Decrease Service /Maintenance Calls

# Potential of Commissioning



- **Shortlist of Lessons Learned**

- Make the Time for a Strenuous CxA Selection
- Start Early in the Pre-Design Stage - Provide up front time for all players to get to know each other and develop a trust
- Define Roles and Responsibilities and then do it again
- Make it a Full Team Effort from the Top Down
- Communicate till it hurts

# The Viability of Commissioning in New School Construction



- Review
  - The Elements of Commissioning
  - The Benefits of Commissioning
  - The Potential of Commissioning
- Conclusion
  - Is it Valid? In our opinion –  
ABSOLUTELY !!
- Discussion and Questions