



The Viability of Commissioning in New School Construction

CEFPI

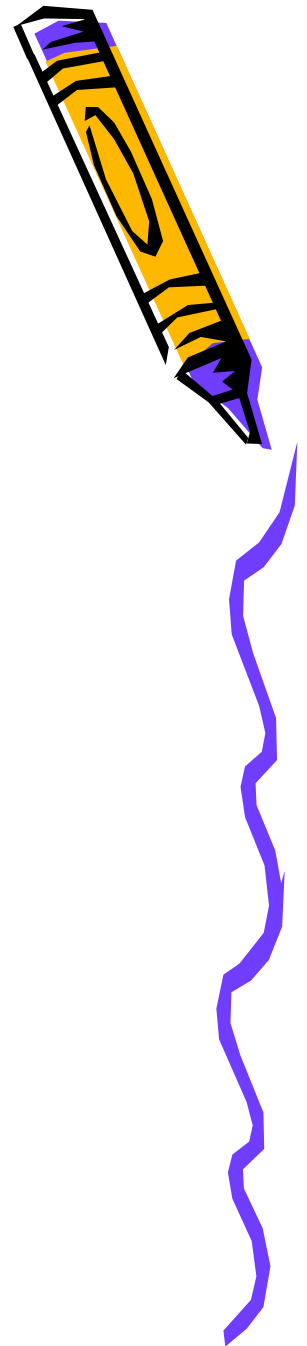
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Your Presenters

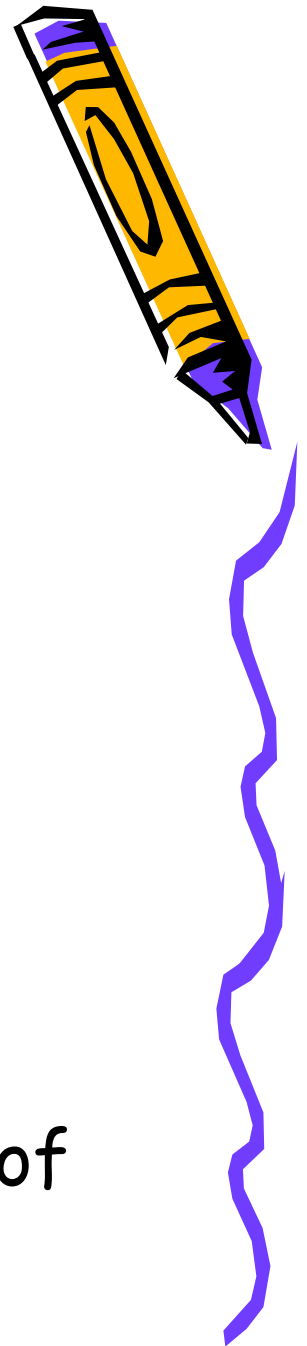


- Joe Martin, P.E.
 - Director of Engineering Services
 - Northside Independent School District

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 - Senior Research Engineer
 - Texas Engineering Experiment Station



The Viability of Commissioning in New School Construction

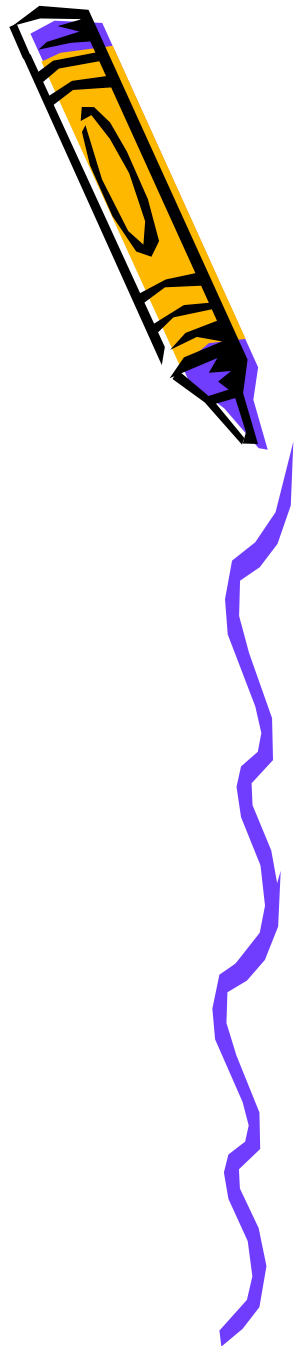


- Overview
 - Elements of Commissioning
 - Benefits of Commissioning
 - Potential of Commissioning
- Basis
 - A Three Year Study and Application of Commissioning in Elementary School Construction



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
- Major Key Players
 - DOE and USGBC
 - ASHRAE
 - AIA and AEE
 - Many More

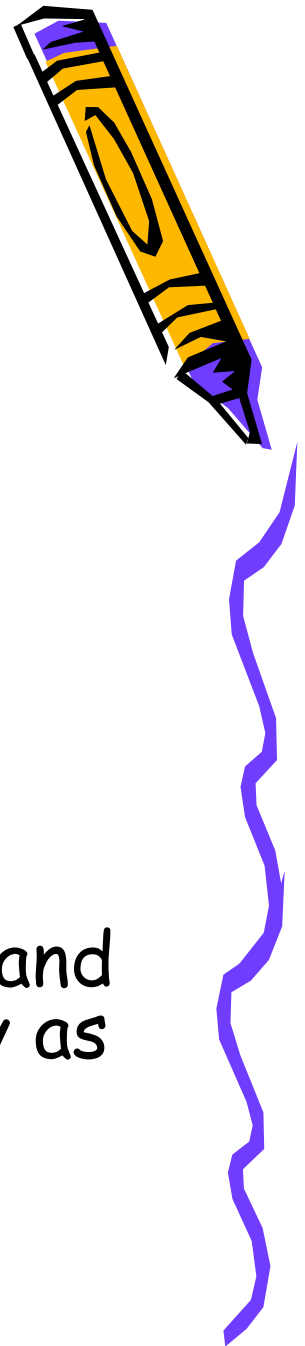


What is Commissioning?

- 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 thereto



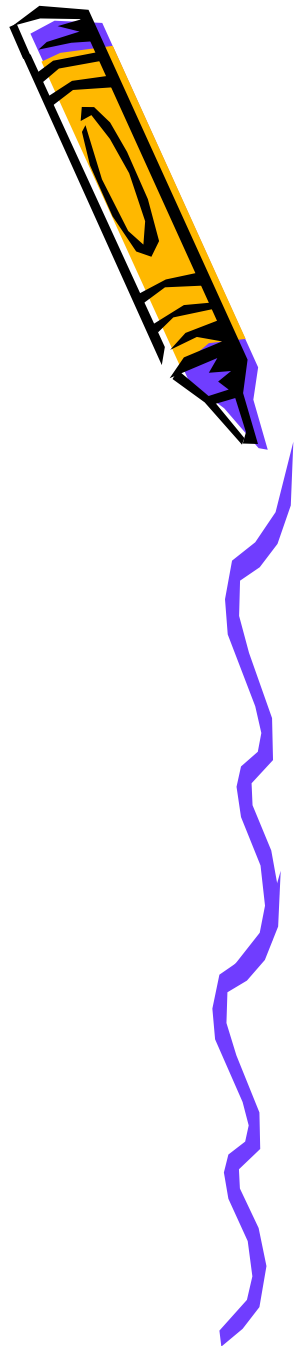
What is Commissioning?

- ... coupled with construction monitoring,
 - Commissioning Authority provides on site monitoring throughout the construction process
 - This variable dependent upon Owner's needs and desires
 - Coordinates with General Contractor (GC) on scheduling issues to avoid "trade-stacking"
 - Provides a conduit for communications amongst all parties depending on level of commissioning
 - Facilitates 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 and Training for Future Use



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

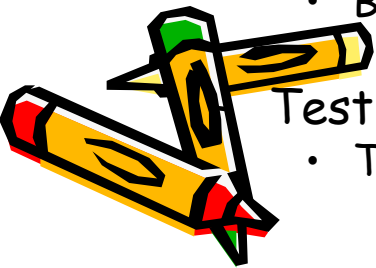
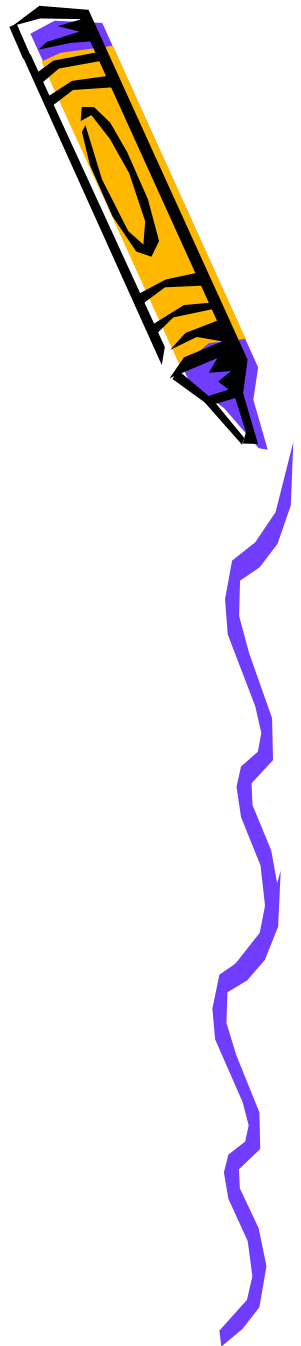
- Background
 - Texas State Energy Conservation Office (SECO) and NISD interested in determining validity of Cx in New School Construction
 - Sustainability Issues
 - Utility Cost Issues
 - Energy Consumption Issues
 - Facility Effectiveness Issues
 - Maintenance Issues



The NISD Study of Commissioning

• Key Players

- Texas State Energy Conservation Office (SECO)
 - Provided Funding for the Study
- Northside Independent School District (NISD)
 - Facilities and Operations Division
 - Facilities Construction Department
 - Engineering Services Department
 - Maintenance and Operations Department
- The Design Team
 - PBK Architects
 - Silber and Associates
- Texas Engineering Experiment Station (TEES)
 - Brooks Energy Sustainability Laboratory (BESL)
- Testing Specialties Incorporated (TSI)
 - 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?

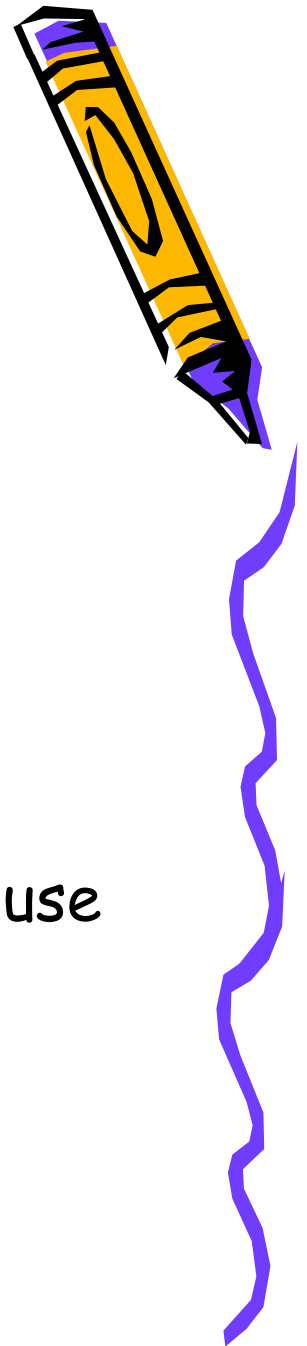


Benefits of Commissioning

- 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



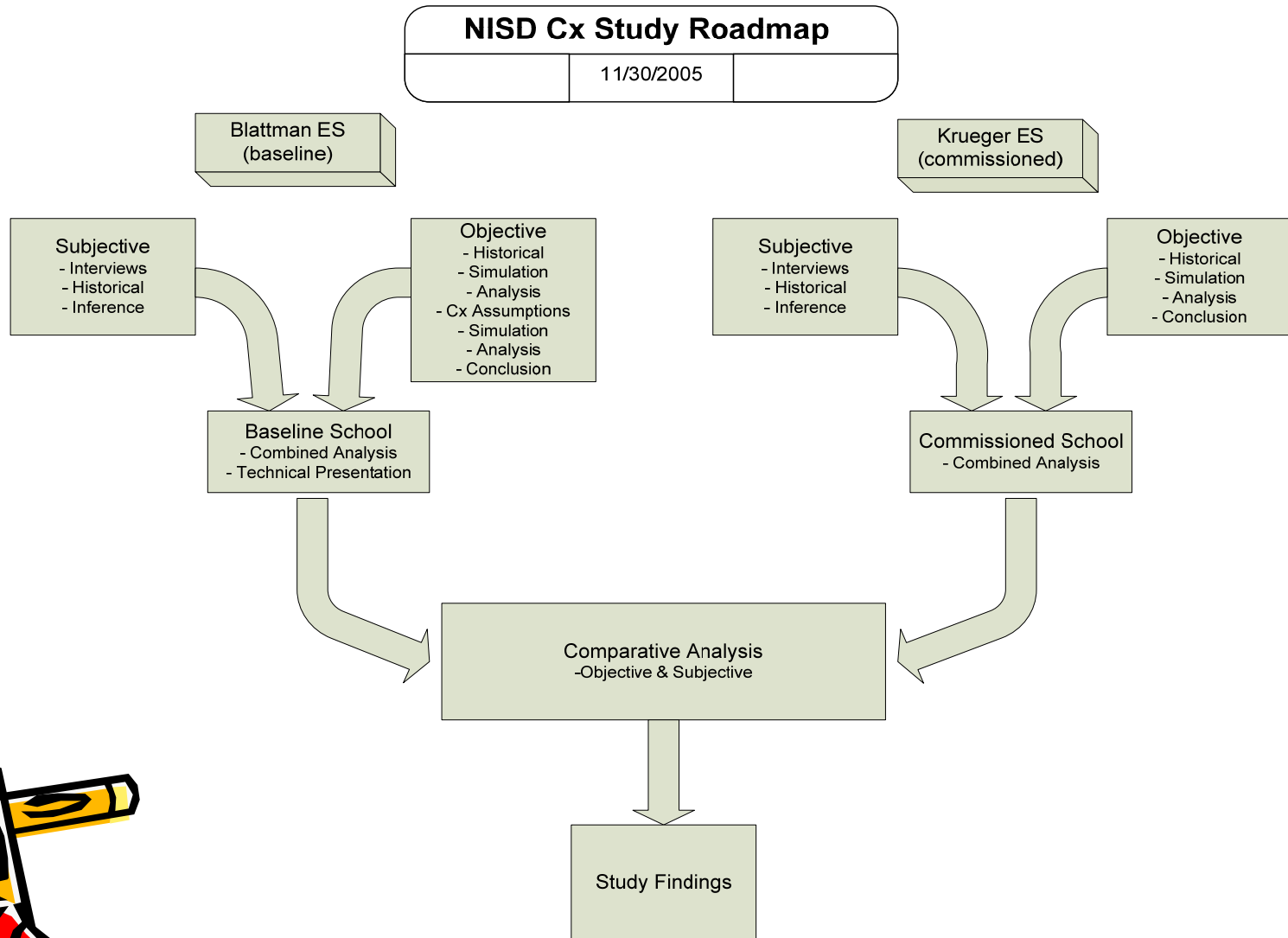
Benefits of Commissioning



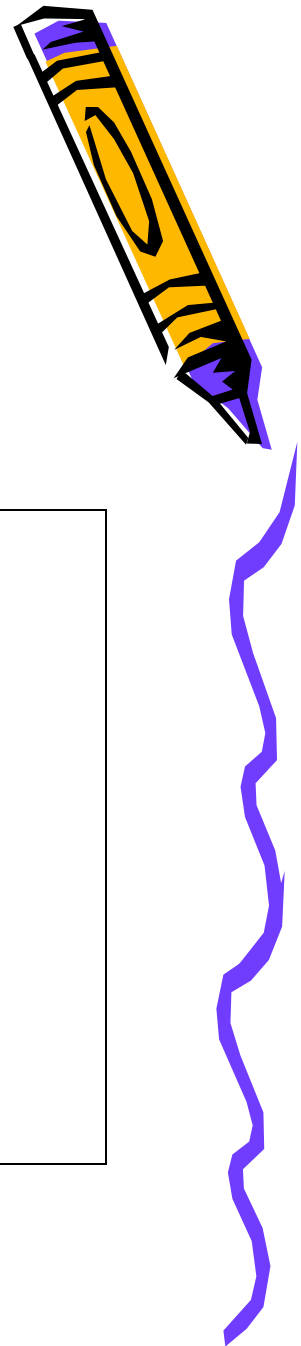
- Study Methodology
 - Develop appropriate metrics for comparison
 - RFI's, Change orders, Punch list, Project timeline, Occupant reported problems, Warranty service, Work orders, Energy use
 - Data gathering
 - Historical vs. real time tracking
 - Utility cost and consumption
 - Quantitative vs. Qualitative



Benefits of Commissioning



Benefits of Commissioning

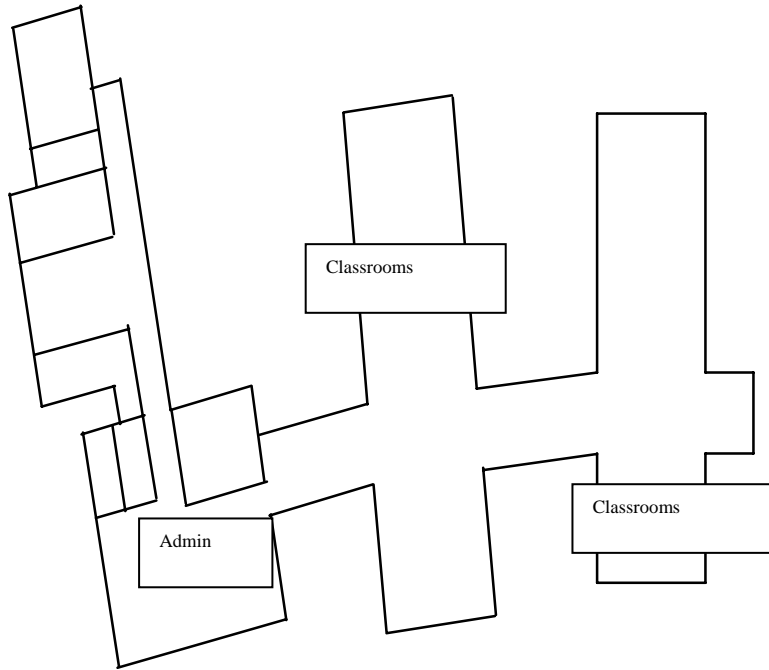


- Study campuses
 - Variations and similarities

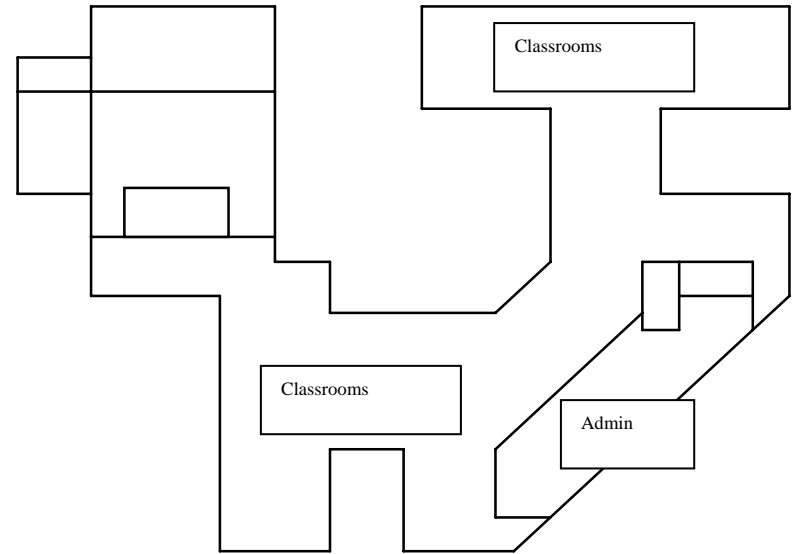
| Characteristic | Baseline School | Commissioned School |
|-----------------------------------|---|--------------------------------|
| <i>floor area</i> | 86,000 sqft | 100,800 sqft |
| <i>number of students</i> | 660 | 800 |
| <i>expected construction cost</i> | \$10,400,000 | \$11,200,000 |
| <i>year 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 |



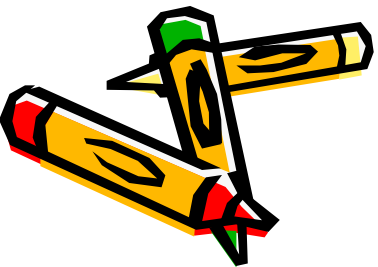
Benefits of Commissioning



Blattman

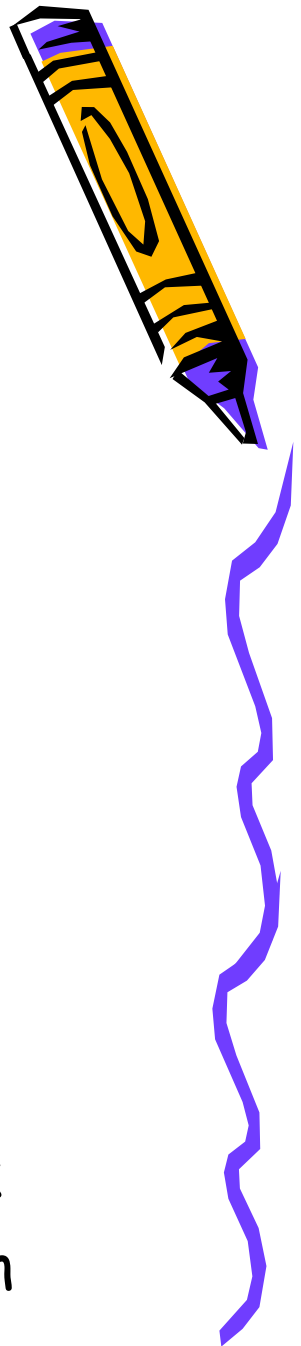


Krueger



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

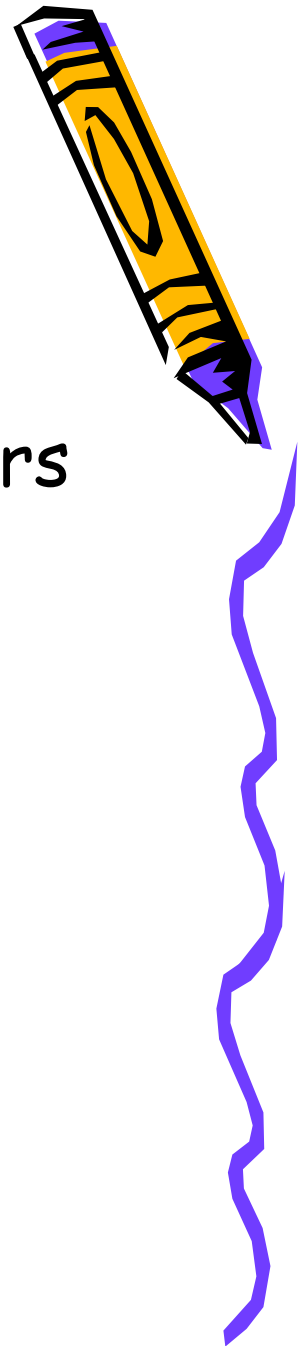
- Metric - Request for Information (RFI)
 - Number of MEP related RFI's
Baseline 22 vs. Commissioned 24
 - Average number of days in review
Baseline 9 vs. Commissioned 13
- Analysis of RFI Metric



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

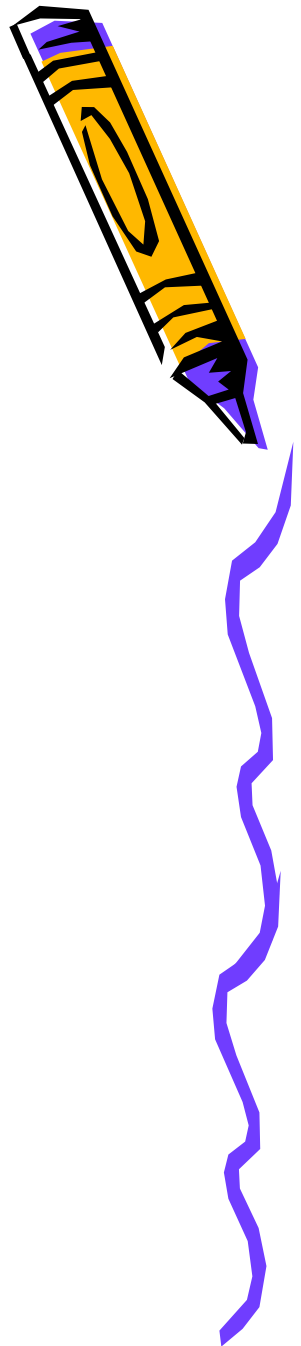
* As a % function of construction cost



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%*

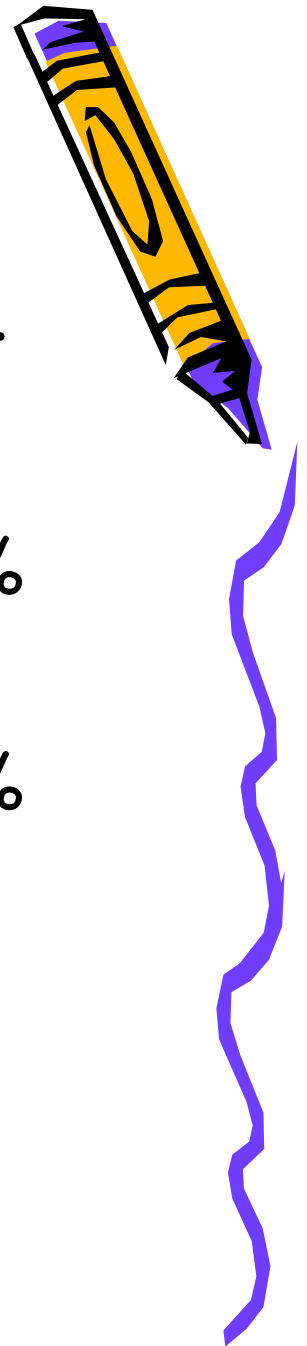
- Discussion of Schedule Metric

- * Difference between expected and actual duration in days

- ** Difference between planned and actual duration in days



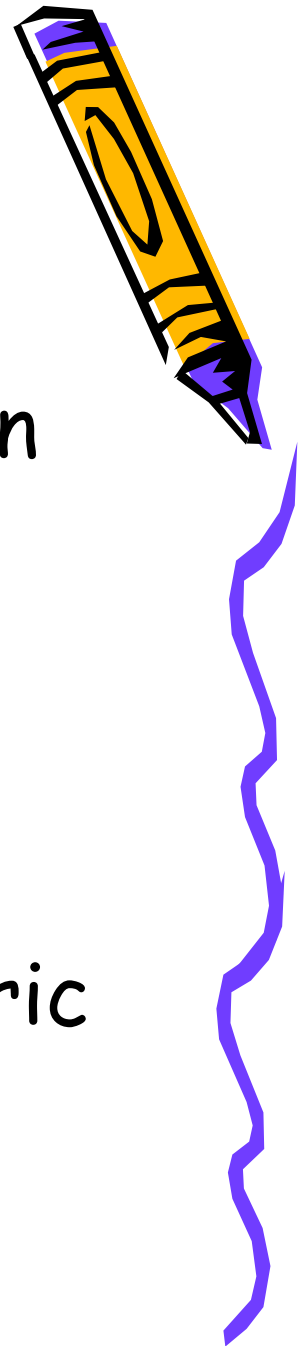
Benefits of Commissioning



- 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*

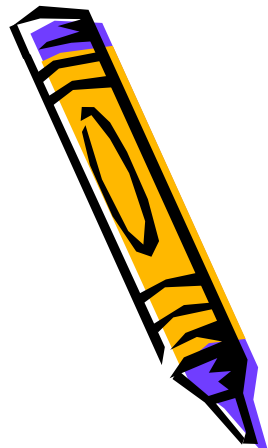
- Baseline 122 vs. Commissioned 116*

- Cost of work orders*

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

- Comments on Work Order Metric

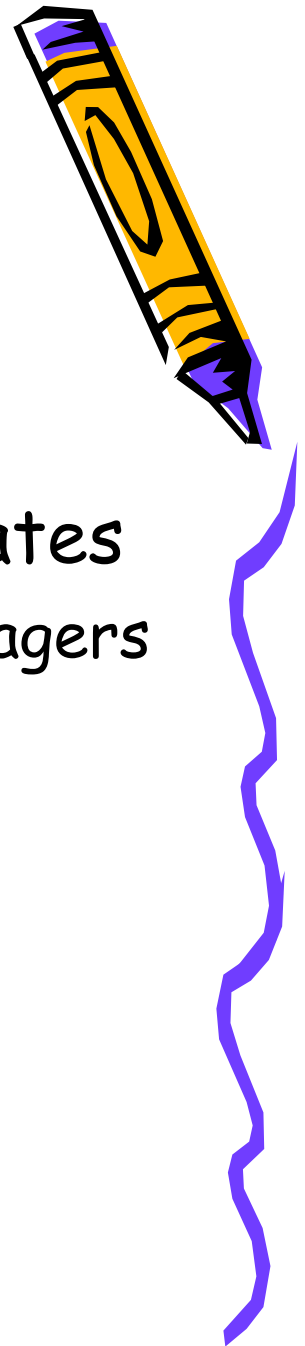
- * based on first six months of operation; includes warranty issues:
includes labor and materials



Benefits of Commissioning

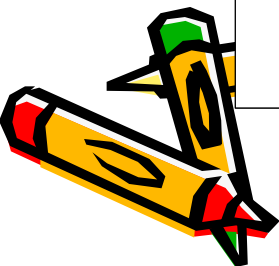
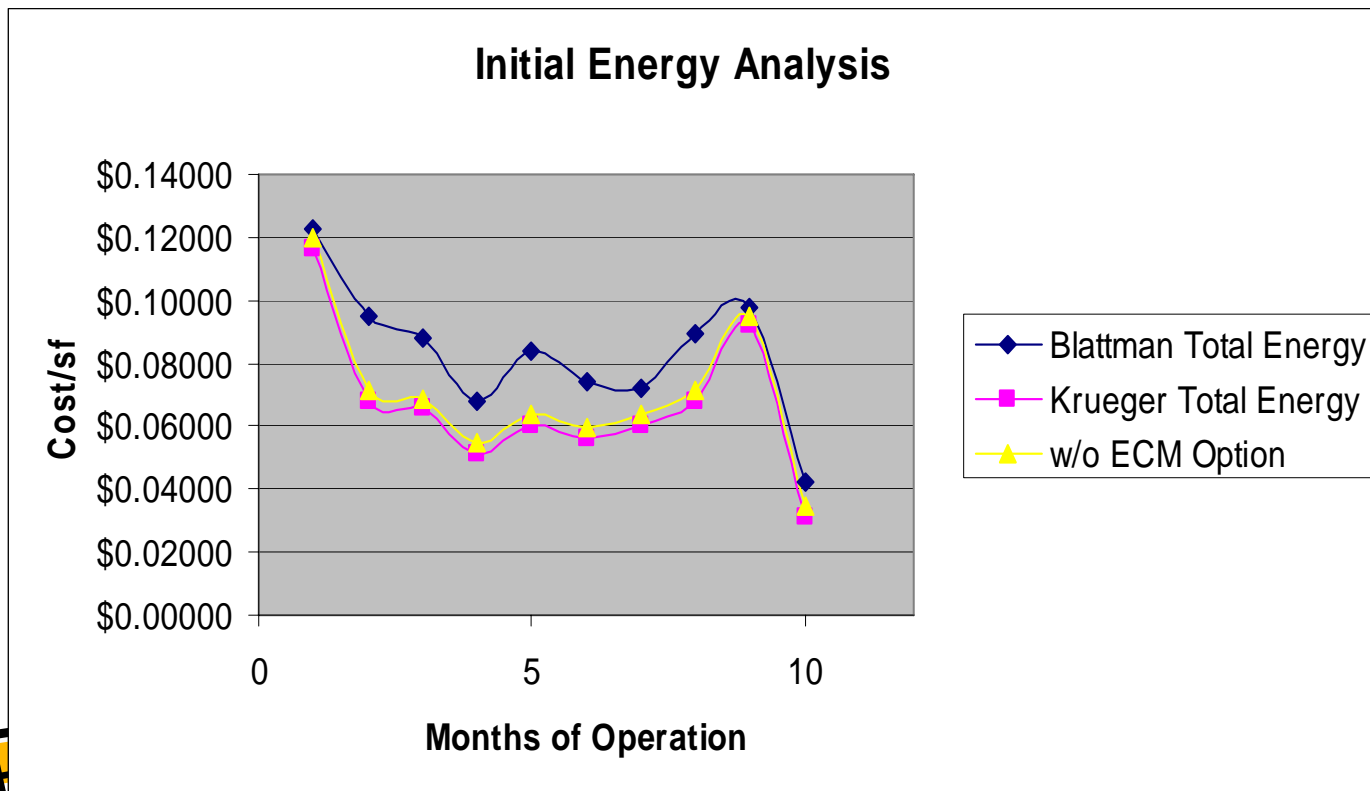
- Metric - Energy reduction*
 - Approximately \$0.016/sf/month
 - Trend analysis for both facilities indicates
 - Active involvement of District Energy Managers
 - EMCS maintaining comfort control within prescribed limits
 - Savings generated by multiple sources
- Comments on Energy Metric

* normalized and based on 10 month school year



Benefits of Commissioning

- Metric - Energy Use



Benefits of Commissioning Recap of Results

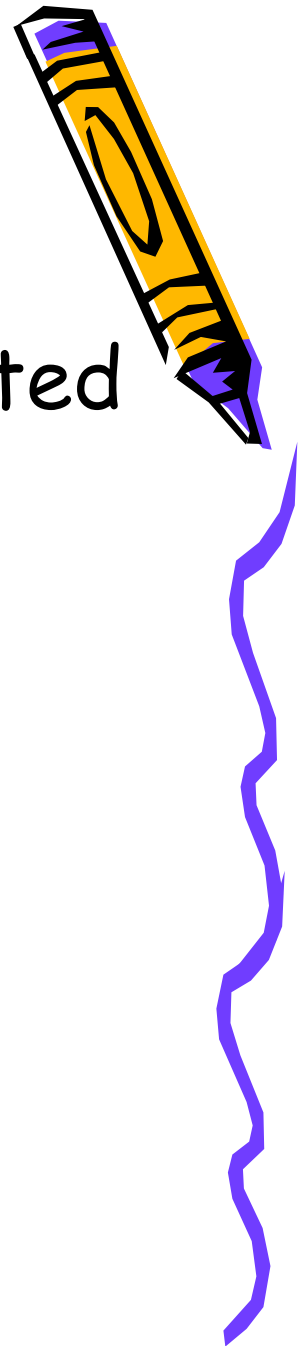


| Metric | Description | Blattman ES | Krueger ES |
|-----------------------|--|-------------|------------|
| <i>RFIs</i> | Number of MEP-Related RFIs (per 10,000 sqft) | 2.6 | 2.4 |
| | Average Number of Days in Review | 9 | 13 |
| <i>Change Orders</i> | Number of MEP-Related Change Orders (per 10,000 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**

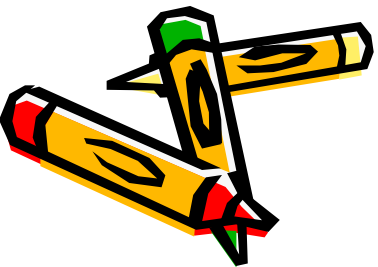
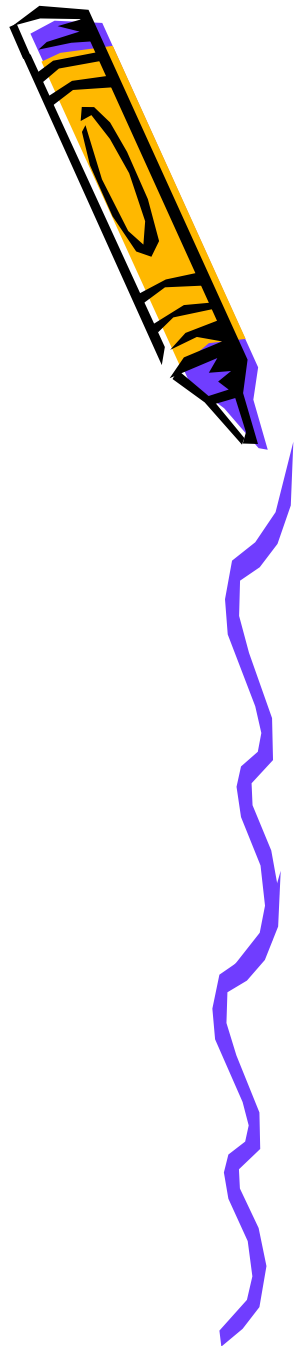
- Building Site Selection and Preparation
- Building Envelope and Orientation
- Building Systems beyond MEP
- Simulation Application



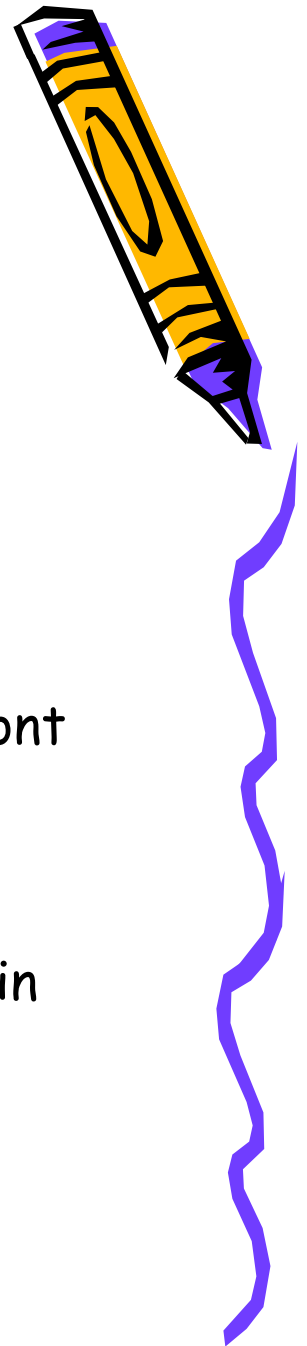
Potential of Commissioning

- **Retro-Commissioning**

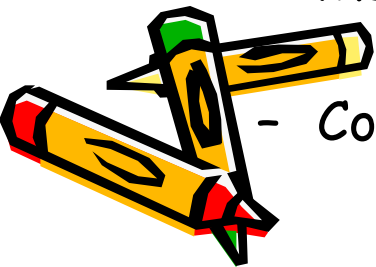
- Equipment Upgrades
- Indoor Air Quality Issues
- Decrease Energy Consumption and Utility Bills
- Decrease Service / Maintenance Calls



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 Validity 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

