Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, San Antonio, Texas.

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John W. Strybos
Alamo Colleges

12th International Conference for Enhanced Building Operations
October 24th, 2012. Manchester, UK.
Outline

- Alamo Colleges, San Antonio, TX.
- Continuous Commissioning® Measures
- Indoor Air Quality Efforts
- Energy Management
- Integration Tool: Alerts System
- Savings Analysis
- Return on Investment
San Antonio, Texas

There are 2391 operational hours used for “free cooling” in San Antonio, TX.
Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

Alamo Colleges: 4,539,334 sq.ft.

San Antonio College (SAC) 1925
1,591,739 ft².
31 Buildings
~ 20,000 students

Northeast Lakeview College (NLC) 2007
367,005 ft².
16 Buildings
~ 15,000 students

Northwest Vista College (NVC) 1995
587,996 ft².
12 Buildings
~ 6,000 students

Palo Alto College (PAC) 1985
571,342 ft².
24 Buildings
~ 8,000 students

St. Phillip’s College (SPC) 1898
MLK: 779,843 ft².
18 Buildings

SWC: 381,195 ft².
6 Buildings
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Outline

Alamo Colleges, San Antonio, TX.
Continuous Commissioning® Measures
Indoor Air Quality Efforts
Energy Management
Integration Tool: Alerts System
Savings Analysis
Return on Investment
Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

ESL – Alamo Colleges

Continuous Commissioning
Indoor Air Quality
Energy Management
Dashboard

AC-EM-IAQ Dashboard
Dashboard Energy Analysis Monthly Reports TDAT File Alerts
Continuous Commissioning®

- **Air Handler Optimization**
  - Occupied/unoccupied schedules
  - Supply air temperature reset schedule
  - Duct static pressure reset schedule
  - Economizer mode
  - Humidity control

- **Terminal Box Optimization**
  - Minimum flow setting
  - Air flow calibration/verification

- **Central Plant Optimization**
  - Chilled and hot water reset schedules
  - Chiller staging

Training of Facilities Personnel!
Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

ESL – Alamo Colleges

Continuous Commissioning

Indoor Air Quality

Energy Management

Dashboard

AC-EM-IAQ Dashboard

Energy Systems Laboratory

A Division of TEES: The Engineering Agency of the State of Texas

Indoor Air Quality (IAQ)

- Installation of IAQ sensors connected to the EMCS
- Monitoring of CO₂ levels, return air temperature and humidity
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Continuous Commissioning

Indoor Air Quality

Energy Management

Dashboard

AC-EM-IAQ Dashboard

Energy Systems Laboratory
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Energy Management

- Technical assistance
- Utility forecasting
- Sustainability and green initiatives

Call the ESL!

LEED certification,
ACUPCC reporting,
Texas Senate Bill 898
Energy Management

- Technical Assistance
- Utility forecasting
- Sustainability and Green initiatives
- Building Sub-metering
Campus Submetering

- Electric, water and gas meters are being installed in each building at every location.
- Set and monitor trend data for electric, gas and water consumption

Consumption in Palmetto Building at Northwest Vista College

Submetering Progress

- Gas
- Electric
- Thermal

NLC, NVC, SPC, SAC, PAC
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Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

Dashboard

District online access:  http://ac-em-iaq/

Energy Analysis
Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

Dashboard

District online access:  http://ac-em-iaq/
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Dashboard

District online access: http://ac-em-iaq/
Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

Trend Data Analysis Tool Lite

![Trend Data Analysis Tool Lite](image)

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ESL – Alamo Colleges

Continuous Commissioning  Indoor Air Quality  Energy Management

Dashboard

AC-EM-IAQ Dashboard

Alerts
Alerts System: Air Handler Units

Read “CC keywords” at AHU Controller

- Pass: OAT < 65 °F
- Fail: Economizer mode enabled?

- Yes: Check CHWV & OAD operation
- No: Is dehumidification enabled?

Calculate ‘Reset SPStPt’ & ‘Reset DATStPt’

- Pass: Compare SP with SPStPt
- Fail: Compare DAT with DATStPt

Compare SP with SPStPt

- Greater: Check if VFD = 0 or VFD > 30
- Less: Check if VFD = 100

Compare DAT with DATStPt

- Greater: Check if CHWV = 0
- Less: Check if CHWV = 100

CC Keywords

OAT: Outside Air Temp.
DAT: Discharge Air Temp.
SP: Static Pressure
VFD: Variable Speed Drive
CHWV: Chilled Water Valve
StPt: Setpoint

alerts system: terminal units (undisclosed)

read “cc keywords” at tu controller

cc keywords:
- dmp: damper position
- space t: space temp.
- priflow: primary airflow
- h pos: reheat position

compare airflow with stpt
- if greater, check if damper is closed
  - yes → data A
  - no → data A
- if less, check if airflow is 2 cfm
  - yes → data A
  - no → check if damper is 100% open
    - yes → data A
    - no → data A

compare space t with stpt
- if greater, check if damper is 100% open
  - yes → data A
  - no → data A
- if less, check if reheat is enabled
  - yes → data A
  - no → data A
Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

Alerts

Detected Alerts in the past 48 Hours

<table>
<thead>
<tr>
<th>Campus</th>
<th>Controller</th>
<th>First Alert</th>
<th>Alert Package</th>
<th>Error</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>NVC</td>
<td>3112</td>
<td>10/18/2012 8:00:00 AM</td>
<td>SP &gt; SP StPt</td>
<td>SP &gt; SPSSPt however the fan is running above 40%. Current Fan Speed is at 100</td>
<td>44</td>
</tr>
<tr>
<td>NVC</td>
<td>3112</td>
<td>10/18/2012 8:45:00 AM</td>
<td>SP &lt; SP StPt</td>
<td>The Fan does not appear to be on when SP &lt; SPSSPt. Current Fan Speed is at 0</td>
<td>41</td>
</tr>
<tr>
<td>NVC</td>
<td>3112</td>
<td>10/19/2012 7:00:00 AM</td>
<td>SP &gt; SP StPt</td>
<td>SP &gt; SPSSPt however the fan is running above 40%. Current Fan Speed is at 100</td>
<td>5</td>
</tr>
</tbody>
</table>

Trends Falling to report in the past 48 Hours

<table>
<thead>
<tr>
<th>College</th>
<th>Trend Id</th>
<th>Name</th>
<th>Link</th>
<th>Station</th>
<th>Point Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest Vista</td>
<td>294</td>
<td>CT1.3 Act Speed</td>
<td>3</td>
<td>503063000 AO</td>
<td></td>
</tr>
<tr>
<td>Northwest Vista</td>
<td>2322</td>
<td>Manzanillo TU-1.4 Space T</td>
<td>3</td>
<td>503220407 AI</td>
<td></td>
</tr>
</tbody>
</table>

Trends Stuck at a Single Value

<table>
<thead>
<tr>
<th>College</th>
<th>Trend Id</th>
<th>Name</th>
<th>Link</th>
<th>Station</th>
<th>Point Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest Vista</td>
<td>104</td>
<td>Texas Persimm AHU-1 CHW Valve</td>
<td>3</td>
<td>503033101 AO</td>
<td></td>
</tr>
<tr>
<td>Northwest Vista</td>
<td>106</td>
<td>Texas Persimm AHU-1 DA Temp</td>
<td>3</td>
<td>503030001 AI</td>
<td></td>
</tr>
<tr>
<td>Northwest Vista</td>
<td>107</td>
<td>Texas Persimm AHU-1 OA Damper</td>
<td>3</td>
<td>503033103 AO</td>
<td></td>
</tr>
</tbody>
</table>
Future Work

- Disclosure of the terminal units engine
- Research and development of alarm systems for central plants
- Performance testing and evaluation
- Generation of work orders using dashboard and alarm systems.
- Facilities training and final delivery
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- Savings Analysis
- Return on Investment
Alamo Colleges Energy Savings

<table>
<thead>
<tr>
<th>Items</th>
<th>Total Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Usage (MWh)</td>
<td>157,505</td>
</tr>
<tr>
<td>Electric Demand (kW)</td>
<td>243,686</td>
</tr>
<tr>
<td>Gas Use (MCF)</td>
<td>424,019</td>
</tr>
</tbody>
</table>

- Ele (MWh)
- Demand (kW)
- Gas (MCF)
Integration of CC®, IAQ, and EM for an Optimum and Proactive Energy Performance at Alamo Colleges, Texas

Annual Savings

Alamo Colleges Annual Savings

<table>
<thead>
<tr>
<th>Year</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2003</td>
<td>$344,150</td>
</tr>
<tr>
<td>FY 2004</td>
<td>$408,621</td>
</tr>
<tr>
<td>FY 2005</td>
<td>$460,672</td>
</tr>
<tr>
<td>FY 2006</td>
<td>$987,449</td>
</tr>
<tr>
<td>FY 2007</td>
<td>$1,058,329</td>
</tr>
<tr>
<td>FY 2008</td>
<td>$999,325</td>
</tr>
<tr>
<td>FY 2009</td>
<td>$999,520</td>
</tr>
<tr>
<td>FY 2010</td>
<td>$1,239,093</td>
</tr>
<tr>
<td>FY 2011</td>
<td>$1,569,485</td>
</tr>
</tbody>
</table>

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Cumulative Savings

Alamo Colleges Cumulative Savings

- Demand
- Electricity
- Gas
- Total

Millions

$9.0

$9.5

$9.0

$8.5

$8.0

$7.5

$7.0

$6.5

$6.0

$5.5

$5.0

$4.5

$4.0

$3.5

$3.0

$2.5

$2.0

$1.5

$1.0

$0.5

$0.0

May-02

Oct-02

Mar-03

Aug-03

Jan-04

Jun-04

Nov-04

Apr-05

Sep-05

Feb-06

Jul-06

Dec-06

May-07

Oct-07

Mar-08

Aug-08

Jan-09

Jun-09

Nov-09

Apr-10

Sep-10

Feb-11

Jul-11

Dec-11

May-12

Oct-12
Outline

- Alamo Colleges, San Antonio, TX.
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The Return on Investment for fiscal year 2012:

\[ ROI = \frac{(2012 \text{ Net Savings})}{\text{Total Project Investment}} \times 100 \]

\[ ROI = \frac{2,189,485}{2,752,041} \times 100 \]

\[ ROI = 80\% \]
Conclusions

The Dashboard Alerts tool is a set of algorithms based on a combination of CC® HVAC and IAQ principles that sends notifications and helps troubleshoot possible scenarios of improper performance.

Alamo Colleges are a model for educational institutions, and continue to exceed the community expectations in environmental responsibility, energy reduction, efficiency and sustainability.
Acknowledgments

**Alamo Colleges**

John W. Strybos  
Associate Vice Chancellor of Facilities Operation and Construction Management  
Facilities:  
Superintendents, Facilities Foreman and HVAC Foreman

**Energy Systems Laboratory**

PI: Joseph Martinez, PCC.  
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Norma Rangel, PhD  

Data Analysis:  
Juan-Carlos Baltazar, PhD  
Alaina Jones (PhD student)  

Dashboard Admin:  
Stephen O'Neal

**Energy Management Control Systems**

Schneider Electric  
Johnson Controls
Thanks!

Questions?
Minimum Airflow

Air Flow (CFM)

Space Temperature (°F)

Before CC  After CC

HHF: High Heating Flow  CHF: Cooling High Flow
HLF: Heating Low Flow  CLF: Cooling Low Flow

Academic FP-101 Reheat Valve Position (% Open)
Outside Air Temperature (°F)

Space Temperature Setpoints and Loads

Energy Conservation Code 503.2.4.2:
Maintain the temperature range or deadband of at least 5 °F
Resets Based on Outside Air Temperature

Supply air temperature reset schedule based on outside air temperature

Supply air static pressure reset schedule based on outside air temperature
**Economizer Mode “Free Cooling”**

- Economizer mode is enabled when the outside air temperature is below 65 °F
- There are 2391 operational hours used for “free cooling” San Antonio.
Humidity Control

Humidity sensors calibrated and verified
Implemented humidity control sequences

• Return air humidity is controlled by opening the chilled water valve
• Reheat may be needed to maintain space temperature
Terminal Box Optimization

- Control the space temperature with airflow and heating stages
- Series: Fan located in the same stream as the supply air
- Parallel: Fan is located parallel to the supply air stream
- CC® Measures:
  - Air flow verification/calibration
  - Minimum flow setting

**Flow (CFM)**

**Space Temperature (°F)**

- Before CC
- After CC

**Symbols:**
- HHF: High Heating Flow
- HLF: Low Heating Flow
- LHF: Low Heating Flow
- HCF: High Cooling Flow
- LCF: Low Cooling Flow
Central Plant Optimization

Chilled Water System

• Chilled and hot water reset schedules
• Cooling tower optimization
• Chiller Staging

Hot Water System

Condenser Water System
### Alamo Colleges Energy Savings

<table>
<thead>
<tr>
<th>Items</th>
<th>Total Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Usage (MWh)</td>
<td>132,359</td>
</tr>
<tr>
<td>Electric Demand (kW)</td>
<td>173,113</td>
</tr>
<tr>
<td>Gas Use (MCF)</td>
<td>361,502</td>
</tr>
</tbody>
</table>

#### Alamo Colleges Annual Energy Savings

- **Ele (MWh)**
- **Demand (kW)**
- **Gas (MCF)**

The chart shows the annual energy savings from FY2003 to FY2011, indicating a significant reduction in energy consumption over the years.
## FY2012 Investment and Savings

<table>
<thead>
<tr>
<th>Year</th>
<th>Project</th>
<th>Paid to TEES (cost)</th>
<th>Savings (return)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2012</td>
<td>Work Order #10</td>
<td>$300,156.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost for Energy Manager w/ Analysis Team</td>
<td>$</td>
<td>$200,000.00</td>
</tr>
<tr>
<td></td>
<td>Specifications for EMCS upgrade/ project management</td>
<td>$</td>
<td>$60,000.00</td>
</tr>
<tr>
<td></td>
<td>Specifications for IAQ sensor installation</td>
<td>$</td>
<td>$20,000.00</td>
</tr>
<tr>
<td></td>
<td>Utility dash board development</td>
<td>$</td>
<td>$40,000.00</td>
</tr>
<tr>
<td></td>
<td>ACUPCC liaison for 5 campuses</td>
<td>$</td>
<td>$200,000.00</td>
</tr>
<tr>
<td>2011-2012</td>
<td>Work Order #9</td>
<td>$331,159.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintain savings from previous CC work (July 2010- June 2011)</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Savings from CC measures implemented on new construction projects (pending analysis)</td>
<td>$</td>
<td>$1,669,485.00</td>
</tr>
<tr>
<td></td>
<td>Work Order #8</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy conservation/alternative energy study for Northwest Vista College</td>
<td>$47,995.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Work Order #3</td>
<td>$49,063.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total $728,373.00</td>
<td>$2,189,485.00</td>
</tr>
</tbody>
</table>