Strategy
Optimize efficiency of building automation, heating ventilation and air conditioning (HVAC), mechanical, and electrical systems. The primary focus is to optimize building energy consuming systems and ensure efficient operation of both building systems and campus distribution/delivery systems, while effectively and efficiently meeting customer needs.

Tactic
Objective 5.1: Test and optimize building chillers, boilers, and HVAC system reliability and operating efficiencies.
Objective 5.2: Raise awareness of retro-commissioning and system optimization process and educate others about the benefits, while obtaining input and support to identify needs and ensure needs are met.
Objective 5.3: Report on building energy consumption and cost, before, during, and after retro-commissioning process to raise awareness of opportunities and results achieved.
Building Retro-Commissioning Program (RCP)

- 99 buildings since 2002
- 13.8 Million Square Feet
- 1992 Campus EUI was 364 mBtu/gsf
- 2012 at 214 mBtu/gsf
- 2015 goal is 190 mBtu/gsf
- Integral component of EAP 2015
- Focus on:
  - Safety
  - Comfort
  - Meeting customer needs
  - Energy consumption and cost reduction
Building Retro-Commissioning Program (RCP)

RC Annual Square Footage

Square Feet

RC Annual Square Footage

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RC Annual Square Footage

Square Feet
### Retro-Commissioning

**Square Feet per Year**

<table>
<thead>
<tr>
<th>Year</th>
<th>Sq. Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>943,849</td>
</tr>
<tr>
<td>2003</td>
<td>1,664,814</td>
</tr>
<tr>
<td>2004</td>
<td>919,784</td>
</tr>
<tr>
<td>2005</td>
<td>401,340</td>
</tr>
<tr>
<td>2006</td>
<td>2,481,077</td>
</tr>
<tr>
<td>2007</td>
<td>795,429</td>
</tr>
<tr>
<td>2008</td>
<td>1,997,701</td>
</tr>
<tr>
<td>2009</td>
<td>1,689,246</td>
</tr>
<tr>
<td>2010</td>
<td>115,797</td>
</tr>
<tr>
<td>2011</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>2,821,088</td>
</tr>
</tbody>
</table>

**Total**

13,830,125 sq.ft.

**Average**

1,257,284 sq.ft./yr
Retro-Commission building selection based on input from several areas:

• Data Analysis Team
• Building Automation Team
• Facilities Services
• Energy Stewards
• Historical Work Orders
Prior to Retro-Commissioning a building or group of buildings, we compare the Energy Use Index (EUI) – measured in mBtu/GSF - and the Energy Cost Index (ECI) – measured in $/GSF - of each building with prior year consumption and peer buildings, to identify potential opportunities.

This analysis requires access to metered energy consumption and cost data for prior 12 to 36 months.

Once this “benchmarking” analysis is complete, buildings to be commissioned are selected and prioritized on Retro-Commissioning Priority List (RCPL).
Identify specific, itemized Energy Consumption Reduction Measures (ECRM) recommendations (including payback calculations) in a document called the Retro-Commissioning Plan (RCP). Recommendations are derived using both the original building specifications (design intent) together with changes in building use with latest design standards.

Standard operational items are quickly corrected, such as:

- Over-Ridden Points
- Systems in Hand, rather than Auto
- Unnecessary preheat-cooling-reheat
- Valves & Dampers not controlling
- Over-Ridden Schedules
Building Retro-Commissioning Program (RCP)

The RCP records occupant requirements for the building and any recommended change to the building design intent. Improvements and enhancement recommendations are reviewed and approved before implementation.

The RCP includes a list of action items recommended for implementation with a proposed schedule, estimated cost and simple payback calculations.

Operations and Maintenance (O&M) improvements are identified in the RCP and work orders are sent to Facilities Services (FS) for correction.

Metered building consumption data and cost, both before and after the RC process, is documented.
A Final Retro-Commissioning Report (FRCR) is created that documents:

- EUI & ECI before and after Retro-Commissioning
- Problems found & corrected
- Additional ECRM’s requiring additional funding or resources along with estimated cost and pay-back

The report documents all work performed, as well as methods, criteria, and results of testing, measuring, and evaluation performed on building systems.

The FRCR documents mechanical, electrical, HVAC and control systems and sequence of operations prior to RC, as compared to a post RC assessment.
### Building Retro-Commissioning Program (RCP)

<table>
<thead>
<tr>
<th>#</th>
<th>Type</th>
<th>Observation</th>
<th>Recommendation</th>
<th>Quick Hit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Optimization</td>
<td>AHUs O, S, and D serve offices, seminar rooms and dining areas, were running 24/7</td>
<td>Implement shutdown or setback schedule</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>Optimization</td>
<td>At the time of investigation, the CHW loop DP setpoint was overridden at 18 psi and AHUs’ CHW valves position was less than 50%.</td>
<td><em>Determine cause for operator override and release the return the setpoint to automatic control.</em> Further Optimize the CHW loop DP reset schedule limits using coil design data.</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
<td>Deficiency</td>
<td>CHW loop DP was calculated by CHWST-CHWRT in PPCL program</td>
<td>Fix CHW loop DP calculation formula</td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>Optimization</td>
<td>Existing return valve control sequence will modulate return valve to maintain loop DP when two pumps were running at minimum speed</td>
<td>Optimize return valve and pump control sequence</td>
<td></td>
</tr>
</tbody>
</table>
# Building Retro-Commissioning Program (RCP)

<table>
<thead>
<tr>
<th></th>
<th>Deficiency</th>
<th>Action</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>HHW loop DP sensor was failed and HHW pump was 100% speed</td>
<td>Fix HHW loop pressure sensors</td>
<td>X</td>
</tr>
<tr>
<td>6</td>
<td>Preheat valve of AHUL3 was overridden at 100% open</td>
<td>Release preheat valve control of AHUL3</td>
<td>X</td>
</tr>
<tr>
<td>7</td>
<td>Pump room temperature was 72°F</td>
<td>Calibrate FCU thermostat and set room temperature at 80°F</td>
<td>X</td>
</tr>
<tr>
<td>8</td>
<td>Preheat setpoint was fixed at 55°F</td>
<td>Optimize the preheat setpoint for all units</td>
<td>X</td>
</tr>
<tr>
<td>9</td>
<td>Energy recovery valve was modulated to maintain supply air temperature at its setpoint. Once CHW valve or preheat valve leaks by, the energy recovery valve may fully closed</td>
<td>Optimize Energy recovery valve control sequence</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>AHU L1 and L2 DAT sensors were out of calibration</td>
<td>Calibrate DAT sensors for these two AHUs</td>
<td></td>
</tr>
</tbody>
</table>
### Building Retro-Commissioning Program (RCP)

<table>
<thead>
<tr>
<th>#</th>
<th>Optimization</th>
<th>Issue Description</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Optimization</td>
<td>Discharge static pressure setpoint was no reset</td>
<td>Implement Static Pressure SP reset schedule for AHUs</td>
</tr>
<tr>
<td>12</td>
<td>Optimization</td>
<td>Discharge air temperature setpoint was reset only according to outside air temperature</td>
<td>Improve discharge air temperature reset schedule</td>
</tr>
<tr>
<td>13</td>
<td>Optimization</td>
<td>Economizer control sequence of non-lab AHUs were reversed</td>
<td>Improve economizer control sequence for non-lab AHUs</td>
</tr>
<tr>
<td>14</td>
<td>Optimization</td>
<td>Both preheat valve and CHW valve control loops for two AHUs (B, O) were using same discharge air temperature sensor as input to maintain setpoint. This may cause the preheat valve to open to preheat air when CHW leaks by.</td>
<td>Use preheat temperature sensor to control preheat valve</td>
</tr>
<tr>
<td>15</td>
<td>Optimization</td>
<td>There are about 15% TECs’ minimum air flow ratio is higher than 30%</td>
<td>Optimize TEC minimum air flow</td>
</tr>
</tbody>
</table>
### Building Retro-Commissioning Program (RCP)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Optimization</td>
<td>Only 8 terminal boxes with minimum airflow setback to zero during Un-OCC mode. The majority of terminal boxes had no minimum airflow setback during Un-OCC.</td>
</tr>
<tr>
<td>17</td>
<td>Optimization</td>
<td>Only six labs (RM221, 224, 220, 230C, 236, 230) with implemented UN-OCC setbacks; the other 80 lab ventilation controllers did not have implement setback schedules. Some labs’ minimum ACH was 10.</td>
</tr>
<tr>
<td>18</td>
<td>Deficiency</td>
<td>Three exhaust air static pressure sensors were out of calibration.</td>
</tr>
<tr>
<td>19</td>
<td>Optimization</td>
<td>All of the three lab exhaust fans were overridden at 100% speed</td>
</tr>
<tr>
<td>20</td>
<td>Optimization</td>
<td>The switch station room temperature was only 69°F</td>
</tr>
<tr>
<td>21</td>
<td>Deficiency</td>
<td>Occupancy sensors cannot control the lighting in classroom 107 and 108</td>
</tr>
</tbody>
</table>
Building Retro-Commissioning Program (RCP)

Discussion