Soda Hall, a computer science building on the UC Berkeley campus, is a good illustration of the impacts of rapid innovations in computer technology on buildings. This 116,000 square-foot facility with classrooms, lecture halls, server rooms and computer labs operates 24-hours a day, seven days a week, and was designed in anticipation of major cooling loads. However, the advent of more efficient computers and internet connectivity – which allows students to work from home rather than in a laboratory – has resulted in cooling loads much lower than expected for this building. The VAV boxes in the facility were all set to provide a higher flowrate than was actually needed, and there were often complaints that the perimeter zones were too cold. Although the campus energy managers were aware of the problem, they did not know how significant the energy savings potential was or how specifically to fix it. They knew that they needed more information about how the building was operating and that a commissioning process utilizing extensive monitoring could provide them with the answers they needed. The UC/CSU/IOU Energy Efficiency Partnership’s Monitoring-Based Commissioning (MBCx) Program allowed campus staff to verify the existence of suspected problems, detect new issues, quantify energy impacts, and implement improvements.

Monitoring the Building Systems
Using the campus-wide energy management and control system (EMCS), the campus EMCS group trends all system variables at one-minute intervals and saves the data for six months. Campus Utilities Engineer Raul Abesamis contracted commissioning provider QuEST to lead the process, perform functional testing procedures, complete data analysis of the monitored points, and conduct an engineering analysis of the building problems and solutions. In-house staff scheduled the tests, manipulated the system during the tests, and was responsible for the implementation of measures.

The commissioning lead used a combination of existing monitoring equipment, temporary data loggers, and a temporary wireless monitoring system to monitor Soda Hall’s energy consumption and system performance. “When you investigate these things you always look for as much data as you can get, and it always comes from different sources. It was very handy to have the data collection at all these different points,” said commissioning lead David Jump.

QUICK FACTS:

Facility Type: 116,000 sq ft building with computer labs, classrooms
Project Date: 2005
Summary: Used historical data supplemented by data loggers to identify performance improvements in a building that was designed for unrealistically high loads.
Benefits:
- Energy Cost Savings (at representative utility rates): $110,000/year
- Energy Saved: 2 million kBtu/year
- Percent Energy Savings: 10%
- Non-Energy: Lower O&M costs, improved comfort and productivity, improved documentation and staff knowledge, properly functioning systems
Costs:
- In-House: $48,000
- Commissioning Providers: $113,000
Simple Payback Period: 1.5 years

Monitoring-Based Commissioning:
California’s public university systems and investor-owned utilities have partnered to provide the MBCx Program, which provides funding to campuses to commission their central or building systems by installing metering and executing functional tests, improving their ongoing performance, and reducing operating costs.
The program allowed us to create an awareness of the operation of our building, and documentation and justification for implementing improvements."

– Raul Abesamis, Campus Utilities Engineer

Investigation
The fact that the EMCS already had available six months of historical data proved to be fundamental for the investigation phase of the commissioning project. The commissioning lead was able to view all of this data, including equipment status and performance trends, and focus on problem areas. The testing phase focused on VAV box functional testing, where air flow and temperature during normal operation were measured. Commissioning found that over the years, the facility operators had reduced the minimum air flows in a few boxes in response to comfort complaints, but that the minimum positions on the VAV boxes were still set at about 50 percent. This meant that they were requiring excessive reheat energy to maintain comfort, especially in the perimeter zones. According to Jump, “It didn’t take long to realize that the problem had been there for a long time, and the program allowed them to realize how much energy savings they could get from closing those boxes. It actually took less to fix it than we thought.” The campus has plans to eventually implement all of the recommended improvements, some of which will be done immediately and others that will be added to the maintenance schedule.

Savings and Costs
As a part of the MBCx project, the campus implemented some of the recommended measures that had the highest energy savings and lowest simple payback periods. They hired a TAB contractor to adjust all of the VAV boxes and set them to a more conservative minimum air setting. If any of these settings cause comfort problems, they will respond to them on a case-by-case basis, although they have not received any complaints to date. They have also made simple but powerful changes to the chilled water reset strategy and implemented improvements in the economizer operation. In total, these improvements have resulted in an estimated savings of about $110,000 per year. In addition to the energy savings, the campus staff is benefiting from improved comfort and productivity and reduced strain on O&M staff from responding to comfort complaints.

The project’s commissioning costs, including investigation, monitoring, and analysis, were about $160,000. In-house costs accounted for about one-third of the commissioning costs. The estimated simple payback period for improvements is about 1.5 years, illustrating the cost-effectiveness of this approach.

Persistence
To help ensure persistence of savings, the commissioning lead completed a final report for the building which includes a wealth of information on the building systems and operations that will support staff in keeping the building operating correctly. The final report recommended ways for staff to maintain savings over time by downloading the EMCS data once a month and running the suggested M&V program to develop diagnostic charts and verify that the energy usage for air handlers and the chilled water system are near expected levels.

The campus is also providing the utilities and energy management staff with monitoring and diagnostics training. Before the project, maintenance was more reactive than proactive, noted utilities engineer Raul Abesamis. Now that the campus staff is aware of the O&M problems addressed during MBCx, they have put a number of issues on the preventative maintenance schedule that will be addressed over time. The operations staff is looking more closely at the operation of the building, which supports persistence of energy savings. Both the commissioning lead and the project manager think that this ongoing monitoring will keep problems from reoccurring and identify new problems that may crop up.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Monitored Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing EMCS Points</td>
<td>Whole building kW, Whole building steam Btu, Chiller kW, Other operation data such as status, valve positions, temperatures</td>
</tr>
<tr>
<td>Added EMCS Points</td>
<td>None</td>
</tr>
<tr>
<td>Datalogged Points</td>
<td>Chiller kw meters on equipment, AHU variables during economizer test</td>
</tr>
<tr>
<td>Sensors validated, calibrated, and/or repaired as necessary</td>
<td></td>
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</tbody>
</table>

MBCx Team
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