



### Award Category

Monitoring-Based Commissioning

### Opportunities Identified with MBCx

Outside air and exhaust dampers repaired and restored to original functioning condition

Chilled water control valves repaired

VFD minimum setpoints reduced on pumps and fans for savings during partial load conditions

### Size

200,530 ft<sup>2</sup>

### Annual Energy and Cost Savings

Electricity: 477,800 kWh

Chilled water: 382,900 ton-hrs

Hot water: 900 MBtu

Cost savings: \$80,800

### Cost

In-house fees \$33,000

Consultant fees \$111,000

### Completion Date

2010

# Monitoring-Based Commissioning CSU San Marcos Kellogg Library

Monitoring-based commissioning is a proven method for achieving energy savings that is effective even in relatively new buildings. At Kellogg Library at CSU San Marcos, electricity use was reduced by 20 percent and chilled water by 62 percent, the result of commissioning and a lighting retrofit.

**K**ellogg Library is a major facility at California State University San Marcos, housing library stacks, study areas, computer labs, classrooms and faculty training spaces. As the building was completed and commissioned in 2004, campus facility staff believed the building to be operating efficiently. When significant operating problems were later discovered by chance, the campus viewed the needed corrections as energy-saving opportunities.



*Kellogg Library at night. Image: Jim Mickelson.*

The problems were uncovered when energy services provider EnerNOC was testing a new airflow sensor technology. Kellogg Library was originally selected as a candidate for the technology as it was assumed to be operating normally. However when the EnerNOC field engineer compared airflow rates in the air handlers to the design flow rates, it was clear that the air handlers were producing far less airflow than expected. Upon further investigation, it was revealed that fire smoke dampers, intended to be closed only in case of fire, were closed permanently, causing poor air handler performance. To resolve this and other potential problems, CSUSM hired EnerNOC to perform a complete monitoring-based commissioning program.

Although the building had been commissioned during its initial construction, the original commissioning agent had been overseen

by the general contractor. In such cases where the commissioning agent is not an independent third party reporting to the owner, the agent may fail to provide due diligence and thoroughly identify all problems, and this is apparently what occurred at Kellogg Library. In addition, the initial commissioning failure established a wasteful energy baseline for the building, so later complaints and utility bills could not be used to identify problems. Even so, CSUSM staff knew something was awry. “We knew the campus was using much more energy per square foot compared to other campuses, but we thought it was because we have a higher ratio of science buildings on our campus,” says Ed Johnson, Director of Sustainability and Utility Services.

**Air handlers were providing only half the airflow they were designed to provide. This alerted staff to the need for more thorough commissioning.**

Using a multi-tier investigation that included three levels of testing (pre-functional, functional, and verification), the MBCx process gave the campus facility staff unique insights into the building’s operation, primarily revealing problems with the HVAC system. One of the significant opportunities was from improperly operating economizers, which were not providing the free cooling they were designed to provide. This was resolved by repairing stuck dampers, slipped and broken linkages, unresponsive actuators, and adjusting dampers to remove excessive play so that economizers would operate properly. Another problem identified was leaking chilled water valves, which consumed excess chilled water when space cooling was not required. The valves were repaired to provide proper flow control and limit chilled water usage to times when it was needed.

Although Kellogg Library had an up-to-date energy management system (EMS), it was underutilized. As part of the MBCx process,

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## More Information

<http://www.csusm.edu/sustainability/>

<http://cx.lbl.gov/MBCx.html>

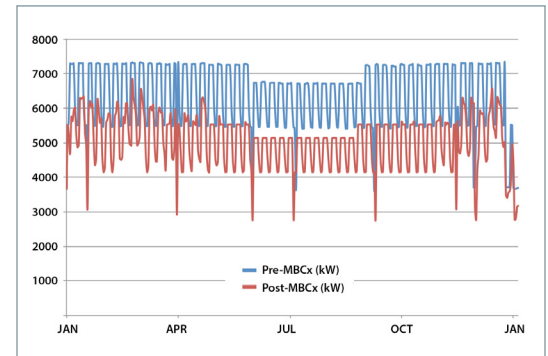
EnerNOC added key measurement points to the EMS, something that was easily accomplished since the basic controls infrastructure was mostly sufficient. “We were very attentive to the points we wanted to add. It doesn’t make sense to add a number of new points in case the data might be useful someday. All those points will overwhelm you and you may overlook the important information you really need” explains Johnson. The EMS system was essential for monitoring temperature, pump and fan speeds, static pressure, and other important data points during the MBCx project.

**EMS data is only as valuable as the quality of the information. After verifying the accuracy of the measuring points, CSUSM had to add, replace, and recalibrate a number of points to establish an accurate baseline. This alone was a worthwhile investment.**

For CSUSM, a large part of the MBCx process is dedicating staff to work with commissioning engineers and being prepared to make in a timely manner the adjustments and repairs the commissioning process reveals. This may be a challenge as many campuses are understaffed and must focus on urgent repairs instead of preventative maintenance. For the Kellogg Library, EnerNOC used a findings log to track measures that were identified, and worked with campus staff to ensure that all participants were satisfied with the results. The campus facility managers decided to perform repairs in-house. Once the list of measures was finalized, campus building services engineers and the campus controls specialist executed the work.

After the MBCx work was complete, EnerNOC compared building energy use before and after the project. Electricity use at Kellogg Library was reduced by 20 percent, partly as a result of the MBCx project and partly as

a result of a retrofit lighting project that the campus implemented in parallel. Chilled water use decreased by 63 percent as a result of repairs to economizers and leaking valves, both of which decreased cooling energy use.



Calculated electricity use at Kellogg Library pre- and post-MBCx. Image: EnerNOC.

## LESSONS LEARNED

Ed Johnson points out that building owners must be willing to continuously invest in building operations, and that commissioning and in-house staff should understand the MBCx goals and intended results. The MBCx process must be a collaborative effort between consultants and campus staff so that repairs can be completed quickly.

Although in-house staff may sense that a building is not operating correctly, they may lack the tools to diagnose problems accurately, and may only address the symptoms, whereas a commissioning agent should have the ability to identify the underlying problem. Conversely, a commissioning agent can investigate problems in a building; however in-house staff are often knowledgeable about the history and nuances of a particular building.

Prior to this project, construction commissioning and MBCx had been treated as different processes at CSUSM. From the lessons learned on this project, the campus now utilizes MBCx in its new construction.

*Best Practices* case studies are coordinated by the Green Building Research Center, at the University of California, Berkeley.

The Best Practices Competition showcases successful projects on UC and CSU campuses to assist campuses in achieving energy efficiency and sustainability goals. Funding for *Best Practices* is provided by the UC/CSU/IOU Energy Efficiency Partnership.



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