BEST PRACTICES 2013

# MBCx at the UCSC Earth and Marine Sciences Building

**A "hybrid" monitoring-based commissioning (MBCx) project combined commissioning activities with control system and equipment upgrades, reducing annual electrical consumption by 14 percent, and peak demand by 24 percent. The cost effective approach yielded a simple payback of 2.9 years.**

**Award Category**

Monitoring-Based Commissioning

**MBCx Measures and System Upgrades**

New BMS and diagnostic software

Installation of variable frequency drives

Occupancy and $CO_2$ sensors in auditorium

Changed air handlers from continuous to scheduled operation

Revised chiller operational sequence

**Size**

149,110 $ft^2$

**Annual Energy and Cost Savings**

Electricity 650,400 kWh

Natural gas 36,050 therms (21%)

Peak demand reduction 183 kW (24%)

Cost savings $112,310

**Cost**

In-house fees $226,116

Contracted fees $100,555

Total $326,671

**Completion Date**

2011

Previous operations at the Earth and Marine Sciences Building at the University of California, Santa Cruz (UCSC) represented a classic example of repairs and maintenance performed in response to occupant complaints and without a long-term view of the building's energy performance. As a result, the building's systems were simultaneously heating and cooling, over-supplying and over-exhausting air, and running well beyond the building's occupied hours.

Constructed in 1993, the building consists of office space, laboratories, clean rooms and lecture halls. The monitoring-based commissioning effort in the building was a "hybrid" approach, combining commissioning with the installation of a new building management system (BMS) and carefully targeted upgrades to HVAC equipment. The team's approach was unique in that UCSC performs their MBCx using in-house resources. Patrick Testoni, UCSC's Campus Energy Manager, explains that the campus prefers using in-house resources because staff are highly familiar with the buildings, the knowledge gained from projects remains on campus, and the approach is less expensive than hiring consultants.

**The key of the success of this project was integrating building commissioning with equipment upgrades, as well as utilizing and building in-house expertise, which allows the campus to maximize and maintain energy savings.**

One of the first steps taken by Testoni and his team was to evaluate the building's monitoring capabilities. The existing BMS, as with many legacy systems, had numerous limitations and was not user-friendly. It required a building operator who was proficient in programming and algorithms in order to make substantial changes, or to leverage the BMS data to its fullest. The team spent significant time researching the most robust and flexible BMS systems, and determined that Tridium Niagara's AX framework best met their needs. They also invested in diagnostic software tools, and selected Activelogix's Periscope and Skyfoundry's SkySpark to provide enhanced monitoring, programming and trending, fault diagnostics, comprehensive alarming, and more efficient control of equipment.

*Evening view of the Earth and Marine Sciences Building. Image: Courtesy of ZGF Architects LLP © Timothy Hursley.*

Once the new Tridium Niagara BMS was installed, a list of MBCx energy efficiency measures was identified, including measures for laboratories, which represented the major share of energy loads in the building. With the integration of the new building controls, campus staff were able to reduce energy usage in the labs by identifying and reducing excessive ventilation of these spaces. This resulted in significant electricity and natural gas savings, while providing increased comfort to building occupants.

Another significant energy efficiency measure was the rescheduling of equipment to address the problem of systems running during unoccupied hours. A review of operations revealed that air handlers serving the office wing were inadvertently scheduled either on the same

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### More Information

http://sustainability.ucsc.edu/

http://svlg.org/wp-content/uploads/2013/05/UC-Santa-Cruz.pdf

http://ucscplant.ucsc.edu/ucscplant/Utility_Distribution/index.jsp?page=Conservation

"24/7" schedule as labs, or in other cases following some other extended schedule not relevant to the actual use of the space.

A third key energy efficiency measure, and one of the system upgrades, was installing variable frequency drives (VFDs) to address over-supplying and over-exhausting air to lecture halls and office areas. Prior to the commissioning and upgrades, supply and exhaust fans were controlled by dampers, which is generally an inefficient way to modulate the airflow, and presented ongoing maintenance problems. A related problem was that the building was over pressurized, with too much supply air being sent to building spaces, resulting in unnecessary energy use from the supply fan motors and the conditioning of this excess supply air volume. The new VFDs resolved these issues, and the fans can now be monitored and adjusted to run more efficiently based on actual heating or cooling demands.

One of the benefits of upgrading the building controls in coordination with MBCx activities was the opportunity to simply operations, verify the impact of changes, and to generally provide more efficient operation of the building's HVAC equipment. To address the problem of simultaneous heating and cooling identified in the diagnostic phase, the project team the simplified the building operational strategy (sequence of operations). Combined with the new BMS technologies installed in the building, operators will be better equipped to readily identify faults, make corrections, and implement ongoing adjustments.

**Campus facility personnel are trained in the use of new diagnostic software that enables them to effectively monitor energy usage and equipment operation. This monitoring is conducted to ensure the continuation of the energy savings.**


*Screen from Periscope advanced diagnostic software. Image: UCSC.*

Twelve energy efficiency measures were implemented and documented in the course of the project. Together these resulted in peak electricity savings of 183 kW (a 24 percent reduction) and a 650,400 kWh reduction in annual electricity consumption (a 14 percent reduction). It also resulted in annual natural gas savings of 36,050 therms, approximately 21 percent in total savings. This amounted to a combined annual cost savings of $112,310 per year, equivalent to an overall simple payback (after incentives) of 2.9 years.

## LESSONS LEARNED

The project team obtained impressive energy savings from a hybrid MBCx approach, combining system upgrades and commissioning. In UCSC's previous MBCx projects, commissioning was performed without upgrading the BMS, and energy savings were significantly less. Even when accounting for the cost of BMS upgrades, UCSC's energy staff found that when MBCx is combined with control system upgrades, the result is a shorter payback period and provides an added benefit of reduced maintenance costs.

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

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