MEETING THE ENERGY CHALLENGE:

RETRO-COMMISSIONING MICHIGAN STATE UNIVERSITY'S 'SHOWCASE PROJECT' - ANTHONY HALL

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In an effort to challenge building owners and the construction and design industry to create more efficient buildings, President Barack Obama started the U.S. Department of Energy (DOE) Better Buildings Challenge (BBC) - (energy.gov/betterbuildingschallenge) - a program that is part of the President's greater Climate Action Plan (http://www.whitehouse.gov) that challenges leaders around the country to "modify and improve building systems and achieve energy reduction of more than 20% by the year 2020."

According to the U.S. DOE's website, "More than 190 organizations have taken the Better Buildings Challenge, representing more than three billion square feet of building space across diverse public and private sectors, more than 600 manufacturing facilities, and close to $2 billion in energy efficiency financing." Organizations committing to the Better Buildings Challenge agree to:

- Conduct an energy efficiency assessment of their building portfolio and pledge an organization-wide energy savings goal.
- Take action by showcasing an energy efficiency project and implementing a plan to achieve lasting energy savings.
- Report results by sharing cost-effective approaches for saving energy and performance data that demonstrates the success.

One of those organizations committed to the BBC program is Michigan State University (MSU) - one of only 21 DOE BBC Education Partners nationwide. According to Namrata Kolachalam, Office of Public Affairs Department of Energy, "The Higher Education sector has many options for committing to sustainability and tracking improvement over time. The Better Buildings Challenge often aligns with other campus sustainability efforts such as building LEED certification or the American College and University President's Climate commitment, where energy reduction contributes significantly to achievement. By setting a goal, these (Education) Partners track their energy performance, share their energy data, and showcase successful projects and models for implementing energy efficiency across their organizations."

According to its website, "In addition to pledging to meet the challenge, MSU is committed to decrease energy use across its campus, utilizing a strategy that profiles individual buildings and identifies upgrade opportunities." Following its determination to pursue the challenge in 2012, MSU created a Building Profile Ranking System and Energy Use Index (EUI) Data, which

The following firms contributed to the Anthony Hall project: Myers Plumbing and Heating, Inc., Lansing; Summit Contractors (electrical), Haslett; Siemens Industry, Inc., (building automation system), Plymouth Township; and Ingenuity IEQ (laboratory monitoring system), Midland.

provided energy data for 40 campus buildings. After careful examination, MSU made the decision to submit Anthony Hall as its "showcase project" for the BBC.

Troy-based Peter Basso Associates' (PBA) commissioning (Cx) group, led by Randy Wisniewski, has provided retro-commissioning (RxA) services since 2007 for more than 70 projects, and Cx services on over 300 projects, since 1993.

PBA's relationship with MSU is almost as extensive as its commissioning experience; including providing MEP engineering design services to the University for over 20 years, on over 125 (including 20 combined Cx/RxA) projects. Like its Cx partners at MSU, PBA was eager to take on the challenge of providing RxA services for Anthony Hall and to be a part of the DOE's BBC.

Anthony Hall is used today as it was intended nearly 50 years ago - as a laboratory/classroom facility. Included within the building are the Department of Animal Science; Department of Food Science & Human Nutrition; Meats Laboratory – USDA Inspected; MSU Dairy Lab Processing and Dairy Store; and university classrooms with a total seating capacity of 891. The building provides space for research performed in keys areas of animal agriculture that are a priority to producers, sustainable agriculture and basic biology, and interface with areas of biomedical and environmental relevance.

Constructed in 1955, MSU's Anthony Hall, a 319,176-square-foot laboratory/classroom building, underwent an extensive renovation in 1997, receiving a $39 million facelift that included a complete mechanical and electrical infrastructure systems upgrade, interior demolition and the installation of research and diagnostic labs.

As a reflection of its long-term commitment to energy conservation and sustainability, MSU joined the BBC and was tasked with making a decision on which project to submit as its "showcase project." Out of 40 buildings, MSU selected Anthony Hall as its ideal pilot project to meet the BBC.

MSU's objectives for meeting the BBC with Anthony Hall were to "enhance safety, reduce waste, increase occupant comfort, reduce greenhouse gas emissions, improve operations and improve energy-efficiency."

Since the renovation in 1997, users and occupants of Anthony Hall had been experiencing issues relating to thermal comfort within the facility that would logically suggest potential deficiencies in the relatively new HVAC systems.

Topping the list of user/occupant complaints in Anthony Hall was a seasonal fluctuation in thermal comfort, lack of ventilation and space/building pressurization issues during both the heating and cooling seasons.

Also concerning was the discovery during the RxA process that Anthony Hall was using 257,544 BTU/square-foot of energy annually - a 20 to 30 percent greater energy usage than comparable building-types.

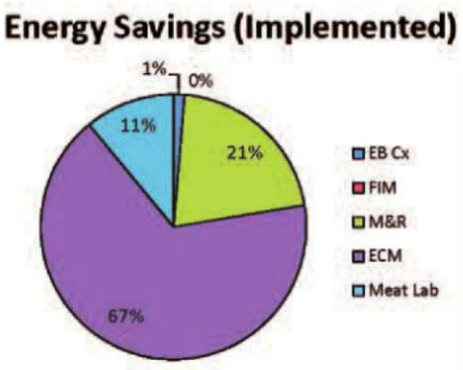
In order to successfully meet MSU's objectives through the RxA process, PBA began with a thorough review of existing building documentation including mechanical as-built documents, as-built control drawings, and building utility data from the previous five years.

Following review of documentation, a third party Test and Balance (TAB) survey was performed by Aerodynamics Inspecting Company of Dearborn, on 100 percent of the existing air handling equipment, hydronic equipment and their associated terminal devices. Aerodynamics prepared and provided test and balance reports to the team that summarized all of its findings.

Following review of existing documentation and the TAB survey, PBA performed field condition assessments and extensive functional performance testing of Anthony Hall's existing HVAC systems, including Air Handling Units (AHUs); air distribution terminal boxes and temperature controls; lab exhaust systems; miscellaneous building/lab exhaust systems; steam and steam condensate systems; heating hot water systems and chilled water systems.

Through the mechanical systems RxA process and the TAB survey, PBA identified mechanical equipment and operational deficiencies that resulted in system control issues, thermal comfort issues and poor energy efficiencies, and placed them into four categories: Deficiencies corrected during RxA; Maintenance and repair deficiencies to be corrected through MSU's maintenance budget (M&R); Energy conservation measures (ECM) which included new technology, new control strategies utilizing existing HVAC components and/or deficiencies requiring engineered repairs; and lastly, facility improvement measures (FIM) which included new technology, new control strategies and replacement of HVAC components.

The pie chart below shows the energy savings for each of the four RxA categories.



(ENERGY SAVINGS GRAPHICS, COURTESY OF PETER BASSO ASSOCIATES, INC.)

Many RxA and M&R repairs - including control setpoint adjustments; repairs to variable frequency drives; repairs to fire dampers and faulty dampers; calibrating fume hoods; thermostat control issues; airflow control devices; corrections to improperly wired return/exhaust fans, etc. - were made by MSU during the RxA process.

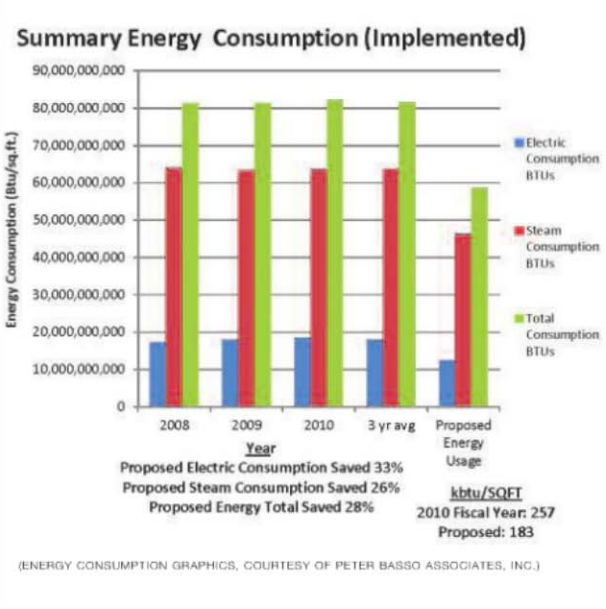
As a laboratory/classroom facility with multiple lab spaces, the facility was designed to have space pressurization controls to maintain laboratory spaces slightly negative to adjoining non-laboratory spaces, while keeping the building as a whole slightly pressurized with respect to the outdoors. During the air handling systems control evaluation, PBA discovered that the building pressurization controls were not functioning. Pressurization control issues had caused a need to override air handling equipment temperature controls and excess outside air to be brought into the building by the building's air handling units. PBA recommended that the airflow monitoring in conjunction with air flow tracking controls be implemented to provide proper space and building pressurization, while reducing the outside air flow.

Also affecting building pressurization, the headered laboratory exhaust systems control was unstable resulting in less than desired laboratory airflow control and increased energy usage. An exhaust re-entrainment/dispersion study was performed by Rowan Williams Davies and Irwin, Inc. (RWDI) that determined that the existing exhaust fan stack velocities could be safely reduced without re-ingesting exhaust into Anthony Hall or surrounding buildings. Based on the results of the study, PBA determined that variable speed drives (VSDs) could be added to the existing constant speed exhaust fans to vary the fan speeds in response to varying laboratory exhaust requirements. This stabilized control of the exhaust systems improved laboratory airflow control improved spatial and building pressurization and reduced energy consumption.

In addition, the following is a sampling of ECMs and FIMs identified and recommendation for implementation to achieve the goals of the project:

- Install/repair insulation on steam, chilled water and hot water piping systems
- Install variable-speed drives (VSD) on cooling tower fans and lab exhaust
- Install air-flow monitoring and repair economizer damper controls
- Implement demand-ventilation control strategies in auditoriums, including measuring air quality
- Install air-quality sensors in laboratories to reduce number of air changes per hour, while at the same time maintaining a safe lab environment
- Install heat-recovery units in exhaust air stream
- Repair or replace failing HVAC system components
- Upgrade building Direct Digital Control (DDC) system
- Replace pneumatically controlled VAV terminal units serving non-laboratory areas with direct digital control (DDC) terminal units; connect DDC terminal units to lighting system motion sensors to reset space temperature control set points and/or close terminal unit dampers during periods rooms are not occupied
- Connect lighting system motion sensors in lecture halls to lecture hall-dedicated HVAC systems to reset temperature control set points

and/or shut down HVAC systems when lecture halls are not occupied
- Install motion sensors at fume hoods to reduce exhaust airflow through fume hoods when fume hoods are not being used, while maintaining a safe lab environment
- Through direct digital control system, schedule and turn off HVAC equipment serving non-laboratory areas
- Convert pressure dependent, variable volume, 100 percent outside air HVAC unit serving Meats Lab to pressure independent variable volume system with air flow tracking
- Conversion of multiple process condenser water cooling systems to variable flow
- Conversion of multiple building reheat systems to variable speed
- Upgrade lighting and install lighting controls (motion sensors)
- Recommend de-commissioning fume hoods that are not in use



(ENERGY CONSUMPTION GRAPHICS, COURTESY OF PETER BASSO ASSOCIATES, INC.)

Implementation of PBA's recommendations for Anthony Hall began in May 2013, with completion expected during summer 2014. Costs for implementation total $5,216,363 with a projected payback period of 8.7 years. Implementing all of the proposed Energy Conservation Measures (ECMs) and correcting system deficiencies is expected to reduce Anthony Hall's current energy consumption by 28 percent, which will bring the building's energy usage in line with more efficient buildings of its type, and will also meet and exceed the DOE's BBC of over 20 percent energy reduction by 2020. It has also created new jobs for local contractors and MSU staff, another important goal of the DOE BBC and MSU.

The graph outlines the energy savings implemented based on the RxA services performed at Anthony Hall.

"The assistance from our consultants with commissioning efforts on campus has been very valuable," according to Lynda J. Boomer, LEED AP, BSEE, PE, MSU Design Administrator. "Bringing in a team of experts to review our systems and operations provides a fresh look at items that have been functioning, but perhaps not operating at peak efficiency. Existing building commissioning process has identified many potential energy conservation measures with a good return on investment."