

White Paper

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Climate Control Improvements-Planning Phase

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Munson-Williams-Proctor Arts Institute

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Munson-Williams-Proctor Arts Institute (MWP AI) successfully carried out all aspects of the project *Climate Control Improvements-Planning Phase*. The project was completed on schedule and without significant deviation from the original work plan. The goal of the project was to understand the causes of fluctuations in the interior climate of the Philip Johnson designed MWP AI Museum of Art and to develop a proposed solution. Williamstown Arts Conservation Center (WACC) was contracted to do a detailed evaluation of current conditions and set temperature and humidity goals for the structure's exhibition, storage and office space. Upon completion of the WACC evaluation, Intelligent Converted Energy was contracted to determine the cause of recorded fluctuations in temperature and relative humidity and establish a work plan for repairs and upgrades that would provide long-term climate control stability for the interior of this landmark museum building.

Climate Control System Improvements-Planning Phase, began in October, 2015 with WACC Object Conservator and Department Head H el ene Gillette-Woodard's detailed assessment of the Johnson building's climate conditions. This assessment was carried out through the collection of data recorded year round by a number of HOBO data loggers in place throughout the Museum exhibition and storage areas. This was followed by an onsite visit. Her conclusions and recommendations were based on the latest industry recognized standards for the exhibit of artworks. Following receipt of the WACC report in November, James Carucci P.E. of ICE carried out extensive data collection and onsite investigation resulting in *Sustainable HVAC Planning Report*. ICE designed this report with the standards set forth in The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Applications Handbook, as its guide. The ICE report contains a thorough assessment of the causes of climate fluctuations as well as a work plan with cost estimates designed to address them.

In the WACC report, Ms. Gillette-Woodard determined that: "The present environment found in the Johnson building correlates directly to changes in the outside environment.... It is when there are changes in the outside environment that the present system cannot maintain a stable environment.... During extreme weather, both the temperature and [relative humidity] would fluctuate 5 to 10 degrees F and 10 to 25% within a given day, week or month. Sometimes the RH would have spikes of a wider range of fluctuation in the spring, summer and fall month(s)."

She describes "unique periods where the RH in galleries can change 20% or above in a 24 hour period. And other than these unique periods of extreme change, there are seasonal periods such as seen in April. In this month all three of the galleries and the

auditorium level show the problem of 15-40% oscillations in RH occurring on a daily basis as the HVAC is responding to changes in the outdoor weather. The temperature as a whole remains stable and only fluctuates on average between 68 and 72° F, which follows the previous approach to museum environments of trying to maintain a very stable environment with no changes. However, trying to maintain the temperature within this tight range all year did not allow for the changes in RH that occurred in response to the exterior weather. These changes in RH may not only be an issue with the old mixing boxes in the HVAC system, but also the insulating envelope of the building.”

Outlining the class of climate control (as defined by the Canadian Conservation Institute’s Environmental Guidelines for Museums) most appropriate for the MWPAI Museum of Art collection, Ms. Gillette-Woodard determined that the goal should be to establish a Type A Class of Control. This would allow for short-term fluctuations in temperature of equal to or less than 5° F and RH fluctuations of plus or minus 5%. Seasonal adjustments in system set points should be up 10% or down 10% for RH, and up 10° F and down 18° F.

Starting in December of 2015 James Carucci, P.E. of Intelligent Converted Energy (ICE), began an investigation into the sources of these recorded environmental fluctuations. ICE is a highly experienced Central New York State company that specializes in developing energy-efficient and environmentally friendly climate control systems. ICE has worked with several central New York school districts, and has previously worked with MWPAI to reconfigure their computer-based energy management systems to increase energy efficiency.

Assessment of Museum classification, requirements, envelope, equipment, controls using site investigation, record drawings, and data acquisition and analysis, yielded the following determinations:

1. Class of Control:
 - a. Type A, with short-term fluctuation and seasonal set point migration must be the goal of HVAC system repairs and upgrades based on the WACC report.
2. Building Heat & Moisture Sources:
 - a. There are two aspects to the ambient affect. These are ambient air conditions, and soil moisture conditions.
 - b. Moisture transmission from unenclosed return air paths is significant and persistent.
 - c. Primary sources of heat transmission are a combination of return air paths, walls, and glass.
3. Building envelope:

- a. Air Handling Units (AHU) return air paths are unenclosed without any form of insulation, air or vapor barrier. This is the source of over 50% of the building's moisture.
 - b. The loading dock interface to the Museum is wholly inadequate for this application.
 - c. The top floor ceiling cavity and exterior walls are bare concrete and pass heat and moisture as water vapor.
 - d. Basement and Sub-Basement exterior walls store and pass soil moisture as water vapor.
 - e. Ground floor exterior glass (windows, doors, atrium).
 - f. Above ground walls are adequate for thermal resistance, and good for air and water vapor resistance.
 - i. Addition of secondary walls (a WACC recommendation) is not a viable option due to moisture control issues.
4. Mechanical equipment general condition and performance is good, with notable exceptions of:
- a. AHU-3 and AHU-4 supply air flows are too high, thwarting dehumidification performance.
 - b. 101 Mixing Boxes (dating to 1959), which are designed to flexibly mix outside and inside air, are aging and use unreliable pneumatic controls. Recalibration is an exercise in futility. Parts and instrumentation are no longer readily available. At any given time roughly two-third of the mixing boxes are either mechanically impaired or out of calibration.
 - c. The loading dock fan coil unit is inadequate for this application.
5. Energy Management & Control System (EMCS) which provides control of temperature/humidity:
- a. Provides incomplete monitoring and control of critical equipment (Mixing Boxes, Humidifiers).
 - b. Provides woefully inadequate environmental control stability, accuracy, and energy management.
 - c. The infrastructure (server, field controllers) is old technology and relatively unreliable.

ICE's investigation yielded the following recommendations in order of project impact:

1. AHU-3 and 4 return air paths must be fully enclosed, sealed and insulated in order to eliminate the current significant compromise of system environmental control performance, in particular RH fluctuations.
2. The current Carrier EMCS must be replaced in favor of a system that will enable implementation of algorithms and features that are appropriate for a Museum application. Mechanical systems cannot perform properly, for a

- Museum application, without this measure.
3. AHU-3 and AHU-4 supply air flows must be reduced, and capable of variable speed adjustment, in order to enable better system dehumidification performance, as well as reduce energy consumption. They currently operate at constant volume.
 4. All 101 mixing boxes and controls must be modified and integrated with the new EMCS. Spaces can't be balanced to loads without these combined measures.
 5. Loading Dock: This is a three-fold issue:
 - a. Add an Air Curtain.
 - b. Replace Fan Coil Unit and controls to integrate with the EMCS.
 - c. Museum interface must include an Air Lock. Loading Dock environment cannot be properly isolated from the Museum without these combined measures.
 6. Replace fan drive transmissions on all system fans associated with AHU-3 and AHU-4.
 7. Top floor ceiling cavity exterior walls should be insulated and sealed against heat and moisture transmission.
 8. Exterior glass (windows, doors, Atrium skylights) should be treated with ceramic films.
 9. Basement and Sub-Basement floors, but not walls, should be sealed.
 10. Chilled Water system should receive pump, specialties, and controls modifications.

Reports from WACC and ICE, the two vendors designated for the project, were carefully evaluated by MWPAI staff to determine the practicality and accuracy of the recommendations contained within them. They were determined to be thorough and detailed. The ICE report provides a credible plan of action for recommended climate control upgrades and repairs and the WACC report provides achievable ranges for temperature and humidity fluctuations.

In one key respect ICE's conclusions differed from those of WACC. The WACC report speculates that the main cause of fluctuations in the Museum's interior relative humidity was the result of seasonal weather changes. While this is certainly a factor, ICE determined that the ground surrounding the below ground floors of the structure was a far greater source of moisture than expected. At the time of construction return air paths were left unsealed and without the ductwork needed to protect against moisture entering the system from the below ground exterior walls.

The direct audience for this project was the MWPAI Museum of Art staff but beyond that, all improvements to the Museum infrastructure positively impact the experience of Museum visitors. Stabilization of temperature and humidity levels within the Museum of Art building will allow MWPAI to display a wide range of art works under appropriate climate conditions. This project will facilitate new loans of objects from other institutions and will make it possible to more readily display some of the most fragile artworks in the MWPAI permanent collection.