Center for Jewish History

National Endowment for the Humanities

Sustaining Cultural Heritage Collections

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White Paper

Optimization of the Preservation Environment

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a. Background

The Optimization of the Preservation Environment (OPE) project provided the Center for Jewish History (the Center) with an opportunity to closely study the systems and infrastructure necessary to maintain the environmental conditions in its collections storage areas. Originally slated to run from October 1, 2015 through March 31, 2017, with an extension granted through September 30, 2017, the National Endowment for the Humanities (NEH)-funded project allowed the Center to analyze the performance of the building envelope and the BMS/HVAC system in moderating the interior environment; reevaluate environmental parameters for collections storage areas; and work with experts from the Image Permanence Institute (IPI) to achieve optimal preservation standards that are both sustainable and cost efficient.

Preservation and access are at the core of the collective work of the Center, its five Partner institutions and their missions. It is the Center's responsibility and challenge to maintain an outstanding facility and provide preservation measures that will prolong the life of the collection materials. Since 2011, when the Center received the NEH-funded preservation assessment written by John Dean, which offered recommendations on improving the preservation environment, the Center has been improving its ability to monitor and assess its capabilities. This most recent project dramatically increased the Center's capacity to gather and analyze quantifiable data and recorded information about the environment and systems.

The Center for Jewish History is housed in five structurally and mechanically combined buildings served by 17 separate air handling units (AHUs). The more than 56,000 square feet of storage space that is collectively referred to as "the stacks" encompasses eleven of the Center's floors and is served by two dedicated AHUs (AC9 and AC13). Prior to the beginning of this project, the Center's building management system (BMS) was programmed to achieve prescriptive targets of 70° F +/-5° and 50% RH +/-5 % in the stacks. Data from climate readers, data loggers, and the BMS indicated, however, that temperature and relative humidity controls throughout the stacks fluctuate regularly and to a large extent. Mold outbreaks in some of the collections areas have been a direct result of these conditions, adversely affecting both collections materials and staff members' health. The OPE project provided the Center with the information required to immediately begin ameliorating these conditions, and to justify and plan for future large-scale improvements. Center staff gained the capacity to speak clearly and knowledgeably with Center and Partner colleagues about preferred collection management procedures, resulting in better professional relationships and improved decision-making ability.

The Optimization of the Preservation Environment project provides a striking practical example of the importance of quantitative data and professional cooperation when defining and setting parameters for collections storage. Collaboration, not only within the Center, but also with the five Partner organizations that utilize and control the space, was needed in order to achieve a goal to benefit the entire Center community through long-term preservation of collection material. A broad spectrum of professional knowledge is required to identify the needs of the collection materials; evaluate existing storage conditions; assess the realistic capabilities of the air handling systems and the extent to which the building environment helps or hinders the performance of those systems; identify sustainable practices or changes that improve the functionality of the systems; and communicate these realities to stake-holders. Collecting and assessing the quantitative data allows stake-holder staff to effectively convey information to board members and directors in order to educate them on the importance of optimizing the Center's environmental control.

b. Activities

The Optimization of the Preservation Environment project was a collaborative effort, engaging various teams of individuals from the Center for Jewish History, including Preservation Services, Archive and Library Services, Building Operations, and Engineering staff, as well as outside consultants from the Image Permanence Institute. Center staff were charged with conducting monthly environmental monitoring by reading data loggers and analyzing the information using IPI's eClimate Notebook software, communicating with each other and with the Partners regarding desired and realistic preservation storage environments, and educating themselves regarding all aspects of the building's air handling equipment and building management system. IPI consultants were tasked with providing an in-depth study of select mechanical systems and making suggestions for optimizing the performance of those systems, identifying opportunities for energy and cost savings, analyzing the preservation quality of the current storage environment, and making suggestions for improvements in Center systems and policies that would result in sustainable improvements in the quality of the storage environment.

Project Background

Investigation of the preservation environment at the Center for Jewish History was identified as a key issue when the Center hired its first Preservation Services Manager in 2013. Environmental monitoring began in June of 2013, beginning with one trial data logger and quickly expanding to 15 loggers in various storage, exhibit, research, and office locations, downloaded and analyzed monthly. Stand-alone loggers were mainly in use, namely Onset Hobo UX100-003 and UX100-11 with IPI's eClimate Notebook as the analysis software. Wireless loggers (Lascar EL-Wifi TH+) were placed in selected exhibit cases. Monitoring in the stacks began in 2014, starting with the fifth and sixth floors of the 18 West 17th Street building (stack spaces 5B and 6B). Analysis of the data showed routine fluctuations in both temperature and relative humidity, with episodic extreme fluctuations in RH that closely tracked outside conditions (see Figure 1).

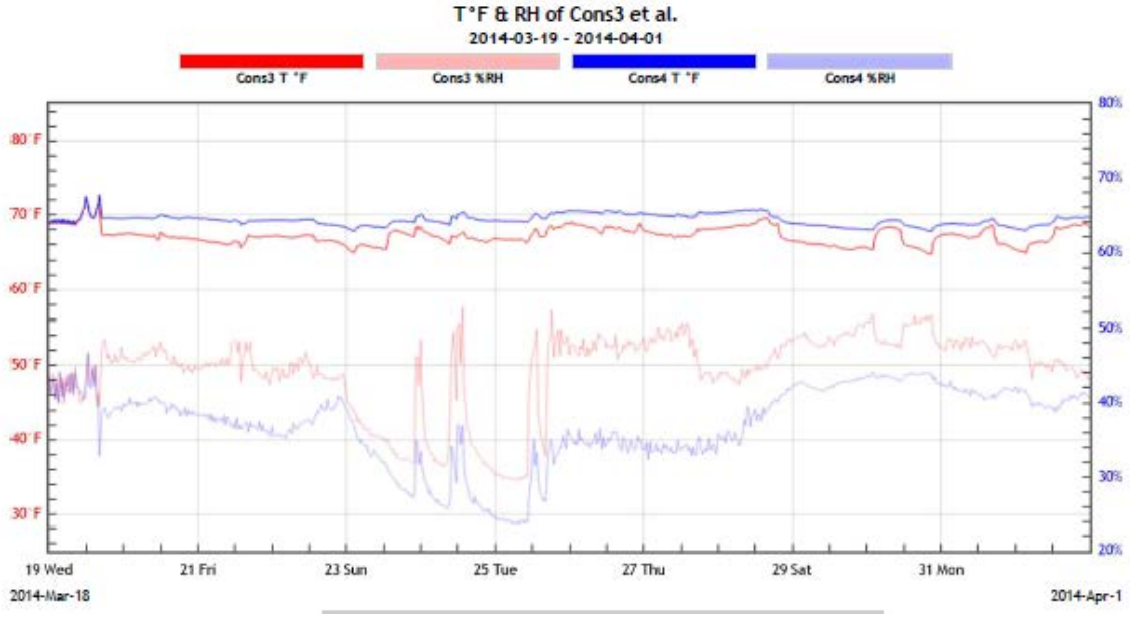

Figure 1.

In 2015, stack monitoring expanded to include all of floors 4-12 in both 18 West 17th Street ("B" side stacks) and 20 West 17th Street ("A" side stacks). Analysis of the monitoring data combined with professional development led to a more nuanced understanding of the sub-optimal quality of the storage environment in the stacks. It also caused the Center staff to question the goals and bench marks it had set for that environment. After attending the 2014 American Institute for Conservation of Historic and Artistic Works (AIC) annual meeting, Center staff came to a more nuanced understanding that a too rigidly defined preservation environment is not always appropriate and that ranges should be established according to particular collection needs and air condition system abilities. At that point the Center developed the Optimization of the Preservation Environment project with the ultimate goal of gaining, and then applying, knowledge about the collections, and reconciling collection needs with institutional priorities that move the Center toward more sustainable and effective operations.

Phase 1 (October 2015-March 2016)

The OPE project kicked off with a site visit to the Center on October 20-22, 2015. Project staff in Preservation Services, Archive and Library Services, and Building Operations prepared for the visit by watching three IPI webinars in their "Sustainable Preservation Practices for Managing Storage Environments" series in order to establish a baseline level of knowledge. The team also gathered analog and digital copies of mechanical and architectural drawings for all relevant stack spaces as well as specifications for the two stacks-serving air handling units, AC9 and AC13. The focus of the first site visit was on information gathering and documentation. After an initial review of project objectives and methods, IPI and Center staff toured all 17 stack spaces, focusing on the general layout, location of HVAC vents and ductwork, and known locations of past leaks and mold. The team also inspected AC9 and AC13, with IPI annotating mechanical and architectural drawings and noting supply and return air paths. The IPI consultants increased the capabilities of the environmental monitoring program by placing eight PEM2 electronic preservation environment monitoring data loggers in the supply and return vents in four stack spaces, four loggers in the AC13 AHU, and four loggers in the AC9 AHU. Finally, IPI consultants and the Center's Preservation Services Manager gave a presentation outlining the overall objectives and timeline of the project to the larger Center staff and to the Partners' collection managers.

After that initial meeting, the data from the IPI-installed loggers was collected monthly by the Preservation Services Manager and staff with the assistance of the Building Operations engineers and Center/Partner collection managers. This data, along with the data generated by the Center's own suite of 43 data loggers, was uploaded to the Center's eClimate Notebook account where it could be accessed and analyzed by the Center's project team and IPI. This data informed bimonthly meetings of the Center's project team and sparked discussion on system optimization and passive environmental control capabilities.

In March 2016, a key OPE team member position, Preservation Services Manager, was vacated and was quickly filled.

Phase 2 (April 2016-September 2016)

After the new Preservation Services Manager surveyed research, data analysis, and events following IPI's initial site visit, the Center's OPE team met to begin targeting specific problem areas of the various parts

of the HVAC system and the built environment of the stacks. In a meeting in bimonthly May 2016, the team identified four areas of inquiry as priorities to address:

- Repeated trouble with the DriSteem humidification systems associated with the AC9 and AC13 AHUs;
- The inability of the DX coil in the AC13 AHU to provide an adequate environmental control;
- Ongoing, seasonal mold growth around hatch doors and adjacent walls on floors 5 and 6 of the stacks ("B" side of stacks);
- New mold growth discovered in March 2016 on the North wall of the 5th floor stacks ("A" side).

These matters were the focus of IPI's second site visit on June 9-10, 2016, along with general project goals and quantitative data analysis. The first day of the site visit was spent reviewing the Center's priorities and an inspection of the stacks and the AHUs on the roof, with special attention paid to known problem areas. The OPE teams were joined by representatives from the Center's building management system provider, AME Inc., on June 10. The AME staff was able to provide more information about the capacity of the AHUs and the sequence of controls for the units. Finally, the Center team and the IPI consultants met on the afternoon of June 10th to perform a comprehensive analysis of all quantitative data captured to date and discussed general recommendations relating to the four stated priority areas.

During the course of the visit IPI had determined that the hatch doors on floors 5B and 6B of the stacks were not properly framed out during construction, allowing outside air to flow freely into the interstitial space between the exterior and the interior walls. The Center team took the following steps to reduce risk of recurring mold growth associated with the hatch doors:

- Beginning in June 2016 a program of bimonthly wall surface temperature monitoring was initiated. The Preservation Services Manager collects readings with a handheld, non-contact, digital laser, infrared thermometer. Readings are taken and recorded in areas where mold growth was previously identified, as well as other sites along the stack walls. During the project period readings were shared with IPI and were considered in conjunction with the environmental data already collected to determine the extent to which exterior wall surface temperatures interact with ambient temperatures and available humidity in the air to initiate mold growth.
- In August 2016, the Director of Building Operations and Preservation Services Manager carried out a visual examination of the interstitial space near past mold outbreaks using a digital inspection scope attached to a mobile smart phone to enhance understanding of a previously inaccessible space and to inform subsequent decisions around sealing methods and materials.
- In September 2016, Center Building Operations staff sealed around the hatch doors on floors 5 and 6. The exterior of the hatch door frames were taped, framed out, and sealed with insulating spray foam. Once dry, a protective layer of stucco was applied over the spray foam.

Informed by analysis of the environmental monitoring data and visual examination of the North wall of the 5th floor stack, IPI consultants suggested that the new mold growth found in March 2016 was likely the result of a combination of building envelope deficits, the interior and exterior environmental conditions during the winter of 2016, and localized poor air flow. Recommendations for this space included implementation of a more robust monitoring program, facilitation of greater local air flow by moving materials away from the wall, and possible seasonal HVAC adjustments. In response to the new,

enhanced monitoring program and the hatch door sealing project, the Preservation Services Manager provided Partner staff with training in mold identification and established a response protocol. A program of regular visual inspection by Center and Partner staff is an integral part of the monitoring program.

Phase 3 (October 2016-March 2017)

During this phase of the project, the Center team further researched building specific and "best practices" topics required to build a well-informed plan for optimizing its preservation environment. The team measured HVAC performance and energy efficiency, considered current professional preservation standards for collections storage, gathered information about fiscally responsible investments that could be made to upgrade mechanical systems and increase efficacy, and studied performance of the building envelope and other relevant building science topics.

In November 2016, the Center and IPI project teams had a conference call to discuss project progress and address priority topics such as the efficacy of the recent hatch door sealing; the newly enhanced monitoring program; and possible testing of HVAC set point adjustments to reduce risk of future mold growth and provide a better preservation environment. Regarding the hatch doors, all agreed that sealing them had proven to be a cost- and labor-efficient solution. The enhanced monitoring program was deemed helpful and worthy of continuation as the team works toward a more comprehensive understanding of the building and its equipment. Team members discussed the potential benefits of adjusting the temperature and relative humidity set points for the stack spaces during the winter and summer months to improve the general preservation environment and help maintain conditions averse to the growth of mold in known problem areas.

Unexpectedly, the Center's building management system failed in December 2016. Though the Center's BMS was nearly 20 years old and known to be problematic, its failure at this particular time came as a challenge. There was no way to reliably and automatically control the building's mechanical equipment, including AC9 and AC13. The Center immediately took steps to remedy the situation, including consulting with IPI and receiving valuable guidance. In mid-February 2017, the Center signed a contract with its longtime BMS vendor, AME Inc. A Project Manager from Innovative Construction & Design Solutions was hired to oversee the phased installation of a new BMS. The installation of the new system was successfully completed in April 2017.

IPI made a third site visit on February 15-16, 2017 to review accumulated quantitative data and to help re-evaluate project goals in light of the failure and subsequent replacement of the BMS. Even before its complete failure, the data from the environmental monitoring program had made it clear to the team that the old BMS was unable to produce the programmed set points. One possible outcome envisioned at the outset of the project was that data analysis might lead to a recommendation from IPI to replace the aged BMS. While the failure of the old BMS was a setback, the new BMS afforded the Center the opportunity to engage in new methods of testing and analysis which in turn would ultimately inform IPI's final recommendations. The February site visit began with a review of project goals and a discussion of the potential opportunities presented by the BMS failure and replacement. After a review of the environmental data collected to date, IPI consultants presented the overall results of the project thus far and recommendations for future action to Center administration, staff, and Partner collections managers. The presentation included plans for testing operation strategies, suggestions for operational changes and energy savings, and aspects of building science specific to the Center.

Following IPI's recommendation, the Center requested a project extension in large part to enable testing with the new BMS in place, and the NEH granted its request. The end date of the Optimization of the Preservation Environment project was moved back to September 30, 2017.

In January 2017, there were additional shifts in the OPE team; the Director of Archive and Library Services and Director of Building Operations were vacated by the original members of the team, but these positions were immediately filled.

Extension (April 2017-September 2017)

The extension allowed the Center to continue monitoring with a view toward ensuring that the new BMS system was maintaining an appropriate environment, especially in the collections storage and exhibit areas. The first phase of the new BMS commissioning was completed in May 2017, with plans for two more commissioning phases including a second season commissioning planned for 2018. The extension also allowed the Center to proceed with testing the limits of its passive environmental controls by scheduling Monday-Thursday nightly shut-downs of stack AHUs beginning on August 14, 2017. Without the daytime heat generation caused by space lighting, equipment, and human occupation, IPI and the Center felt that the building envelope had the potential to maintain appropriate conservation environments in the stacks, even with AC 9 and AC 13 shut down. These shutdowns continued just past the end of the project, into early October 2017; they were paused due to inconsistent temperatures during the shoulder season and upcoming winter freezes. The results of the shutdowns were mixed: while temperatures were maintained during the shutoffs, relative humidity tended to drift up depending on the outdoor environment. The Center's inability to maintain stack relative humidity levels during rainy nights in some areas lead IPI and the Center to the conclusion that improvements to the building envelope need to be made before continuing with shutdowns. The Center does plan on continuing, however—total savings in August alone equaled 32,720 KWH or $15,887.00, as compared with the energy use numbers from the previous year.

The final meeting with IPI representatives occurred over the phone on September 28, 2017. In this meeting the OPE team discussed environmental data analysis of the effects of the shutdowns as well as general observations that IPI's final report would highlight. The problems with the ability of the DX coil in AC 13 to maintain an appropriate dew point and weaknesses in the building envelope were especially emphasized.

During this extension period, the Center's Preservation Associate, an OPE team member, attended the 2017 AIC annual meeting entitled "Innovation in Conservation and Collections Care," gaining new insights of relevance to the OPE project. Of special interest was a presentation on "Evaluation of Climate Control in Yale Peabody Museum of Natural History: Energy consumption and risk assessment." Other presentations given as part of AIC's recently created Sustainability Committee section were also pertinent to the project. Information gathered at this meeting was brought back to the Center and disseminated with the OPE team and is being utilized as the team continues the project.

In the summer of 2017, the position of Preservation Services Manager, a key member of the OPE team, was once again vacated and filled. This position will continue to work as an OPE team member as the project is continued past the grant supported phase.

c. Accomplishments

The objectives of the Optimization of the Preservation Environment project as stated in the proposal were:

- Discovering and achieving optimal HVAC system performance and energy efficiency;
- Establishing conditions that satisfy concerned collections management staff and leaders and build inter-institutional trust;
- Obtain fiscally responsible information regarding investments that could be made to upgrade mechanical systems

One of the most fruitful avenues towards achieving the first goal was the expansion of the environmental monitoring program. The Center expanded its data logger monitoring from six loggers in 2013 to 67 loggers throughout the buildings, greatly increasing the ability to capture and analyze data. In addition, the Center added the capability to measure wall temperature and to view the building envelope by purchasing new instrumentation as a result of issues that occurred over the course of the project. Working with IPI has greatly expanded the Center's ability to evaluate quantitative data and to implement appropriate adjustments based on the data. The results of the Monday-Thursday night shutdowns were one of the greatest accomplishments of this project. Not only did the shutdowns show IPI and the Center what Center systems are capable of. They also demonstrated how the stacks respond and how large the financial and energy savings could be. Knowing what is achievable with building envelope improvements is a huge incentive to make the necessary changes as soon as possible and to continue with seasonal shutdowns.

The increase in quantifiable data allowed the Center to develop a better understanding of the system's capabilities and to use this understanding to implement changes that improve the functionality of the stack AHUs and reduce the amount of work they need to do while maintaining an appropriate preservation environment. Understanding the systems better also allows the Center staff to better explain to the Partners the capabilities of the system and the need to provide protective housings for the most at-risk collections materials rather than depending on energy-inefficient system settings. In fact, having these conversations has increased the sense of shared responsibilities for maintaining the preservation environment among the Center's Administrative, Building Operations, Engineering, and Archive and Library Services departments as well as among the Partner organizations.

The 41-page final report IPI authored for the Center is an especially useful, powerful tool for planning improvements in the built and mechanical structures. The report has allowed the Center to identify specific actions that will improve the ability to provide an optimal preservation environment at lower costs and energy output. The Center has been able to identify three categories of activities that will help to improve the environment: 1) low-cost, in-house fixes such as making sure that all doors in the stacks have gaskets; 2) more expensive projects that will require an outside consultant, such as improving the air balance in the stacks; 3) capital projects that will require a heavy financial commitment but will result in much improved systems, such as replacing the DX coil in AC 13 with a chilled water system.

d. Audience

The Optimization of the Preservation Environment project had a localized audience during the grant period. Most of the information was generated and shared internally among team members with routine check-ins with Center administration and Partners. As the Center continues to generate data, experiment with air handling unit settings, and make improvements to the building and equipment, the Center will be better able to share what has been learned with the larger community of collections holding institutions. A limited number of institutions share the Center's particular concerns in terms of aiming for an ideal preservation environment in spaces that are controlled by five different Partner organizations, but that are maintained by one central organization. To add to the complexity, the Center and Partners share five combined buildings which are served by 17 air handling units. The Center's unique organizational and structural set-up can provide a much needed object lesson in using quantitative data to problem solve and set concrete goals and objectives when dealing with the preservation environment in a complex, consortial setting. However, the white paper will be of interest to many repositories, including those in similar consortial settings, as well as those seeking to achieve improved, sustainable storage environments.

e. Evaluation

The project was evaluated using the following methods:

- Internal meetings among Center teams, Partners, and consultants
- Emails and meetings with IPI consultants
- Evaluation of the preservation environment using IPI's preservation index
- Presentations to Center and Partner staff
- IPI final report

The project's strengths have primarily been the ways in which addressing challenges led to an increase in quantitative data gathering, increased communication within the team, as well as with Partners and outside experts, and proactive discussions about future planning and actions. The main challenges of the project involved unexpected, larger organizational and equipment changes: an unusually heavy staff turnover during the course of the project and the breakdown of the BMS. The impact of the project will be increasingly felt as the necessary improvements are made to Center systems. This impact will continue to be measured by capturing and analyzing environmental data, discussing with the Partners their level of satisfaction with the preservation environment, and hopefully noting a decrease in emergency events such as mold growth and leaks that can cause great damage and loss to collections materials. Future presentations and other types of sharing with the larger community of collections holding organizations will allow the Center to compare its objectives, benchmarks, and successes with those of commensurate institutions and identify more ways by which the Center's preservation environment could be improved.

f. Continuation of the project

The Optimization of the Preservation Environment project has already continued beyond the grant period. The Center continues to capture environmental data from a suite of 67 data loggers, which is downloaded and analyzed monthly along with temperature data captured from 37 different wall locations. This data is actively being used as the Center attempts to institute seasonal setbacks of the temperature and relative

humidity in the stacks and identify external walls with the most pressing need for increased insulation in the interstitial space.

The final report from IPI was received on October 16, 2017 and reviewed by the OPE team in the following weeks. Based on IPI's final report, the Preservation Services Manager generated a punch list identifying easy, low cost changes that will be addressed in 2018; longer term improvements and information gathering that will occur before the end of 2020; and high-impact capital improvements that the Center can request fund-raising around based on the IPI report. The Center is already moving forward with every item on the list of desired changes for the first post-grant project year including making improvements to the building envelope and increasing information sharing between the Engineering and Preservation Services departments. In December 2017, the Preservation Services staff kicked off a monthly preservation newsletter for the Partner community with a one-pager titled "Keeping Collections Safe Through Winter," improving inter-institutional communication around collections care.

The second phase of commissioning for the new BMS began on December 20th, with a kickoff meeting between representatives of the Center's OPE team and a contractor from Innovative Construction & Design Solutions, LLC; the second phase will include AC9 and AC13. The commissioning test report from the first phase provided data on air handling units outside the scope of the OPE project but that nevertheless corroborated IPI and the Center's findings about the building envelope and the capabilities and sustainability of the systems overall. BMS commissioning will continue later in 2018 with a final, second season phase of testing.

Finally, the project will continue long past the time when the Center is able to achieve all the objectives and tasks identified in the punch list. As new systems with superior capabilities are created, as more scientific investigation into the role of environmental factors in the aging characteristics of collections materials is made, as Center staff reach out to similar institutions and compare successes and failures with them, the Center will continue to redefine what is meant by an "optimal" preservation environment, and set new goals for the Center systems and building envelope.

g. Long-term impact

The lessons learned over the course of the Optimizing the Preservation Environment project will ensure that the Center for Jewish History and its five Partners are able to provide long-term access to their physical collections, will enable the Center to run its systems in as fiscally and environmentally responsible a manner as possible, and has created a template for how departments within the larger organizational structure communicate and work together to identify and achieve goals. The OPE project elevated the level of understanding about current, desirable, and achievable storage environments among the Center for Jewish History's staff and stake-holders. The project provides a case study for institutions seeking to achieve improved and sustainable storage environments and shed light on the changing nature of the profession's understanding about the reality of what it means to ensure ongoing access.

h. Grant Products

Due to the nature of this grant, the OPE project has created many strong internal products that are useable by Partners, as well as the Center. Several internal presentations were created and shared with the Center and Partner community, as well as this white paper that was created based on the results of this project.