Environmental Monitoring of University Archives and Special Collections

Final Report and Analysis

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I. Introduction and Background

In December 2018, University Archives and Special Collections (UASC) at Paul V. Galvin Library, Illinois Institute of Technology, was awarded a Preservation Assistance Grant from the National Endowment of the Humanities. This $2,715 grant was awarded to support the first ever systematic environmental monitoring of the UASC spaces. The grant facilitated the purchase of environmental dataloggers which were installed in different parts of the library that house UASC materias to measure temperature and humidity conditions in the spaces over the course of a year. This quantitative data and the subsequent analysis provides confirmation of a problem previously evidenced only anecdotally: a lack of proper environmental control in the main and auxiliary UASC storage spaces. Analysis clearly indicates the potential for accelerated decay and physical damage across all spaces surveyed, and a risk of mold growth in half of the locations. This represents an existential risk to UASC's collections, much of which consists of unique material not held by other repositories on campus or elsewhere in the world. It is imperative that a concerted effort is made to rectify these conditions to ensure that UASC's unique and significant collections are available to researchers for decades to come.

II. Data Collection Procedures

The grant funds provided for the purchase of five IPI PEM2 dataloggers from the Image Permanence Institute at Rochester Institute of Technology. The PEM2 dataloggers were installed in five different locations across Galvin Library, including two corners of the primary (and largest) UASC storage stacks adjacent to the reading room on the library's lower level. Other locations surveyed were the smaller auxiliary storage room next the UASC reading room, colloquially known as "the vault" to UASC staff, the Special Collections room located off of the administrative suite on the library's upper level, and a caged-off room at the west end of the library's closed stacks area. These five locations represent the primary storage areas for UASC collections; two storage rooms in a different building on campus were not surveyed due to an intended focus on Galvin Library spaces, and a hope that eventually, the vast majority of UASC collections can be housed within the walls of the library.

Data was collected monthly via a USB drive and uploaded into IPI's eClimateNotebook software for logging and analysis. Each datalogger collected daily temperature and relative humidity readings for its particular location. These values are useful on their own, but can also be used in combination to determine a location's dew point, which represents the amount of moisture in the air. According to the *IPI's Guide to Sustainable Preservation Practices* (2012), dew point control "is key to managing the risk of material decay." (p. 46)

III. Results

The data collected by eClimateNotebook between March 2019 and March 2020 exhibited the swings in relative humidity and temperature that UASC staff had already noted, generally in line

with the seasonal conditions outside of the library. As a result, dew points in UASC spaces also varied significantly over the course of the year, as illustrated by figure 1.

Figure 1

Location	Temp Min	Temp Max	RH Min	RH Max	DP Min	DP Max
North Storage	63.6	74.3	16	89	22	65.3
Special Collections	65.1	77.1	14	78	19	63.6
UASC East	65.6	77.1	13	84	18.2	66.1
UASC West	66.2	75.9	14	83	18.7	65.6
Vault	67.4	74.6	15	79	20.9	63.2

Relative humidity readings across all measure locations rose and fell in a pattern that broadly mimicked seasonal conditions, beginning to rise in May, and remaining generally high until November. Humidity readings in winter months (November to March) were consistently lower. Even when consistent, however, relative humidity readings across all rooms exhibited frequent swings of 15% to 20%, with more dramatic movement during periods of seasonal transition. Temperature readings were more consistent, with the exception of peaks and troughs that tended to occur in May and October, at times of seasonal transition, when changes are typically made in HVAC settings and outdoor weather conditions.

All locations exhibited humidity variation of at least 64% over the course of the year, and swings in dew point of at least 43 degrees. Temperature measurements, though more consistent, also showed a minimum variation of 11 degrees over the course of the year.

IV. Analysis

Consistency across temperature, humidity, and dew point is optimal for preservation of physical materials. While there is no one single set of agreed-upon recommendations, Douglas W. Nishimura (2011), a research scientist at IPI, refers to common benchmarks of 70 degrees and 50% relative humidity, but advises that these values do little to accurately capture risks to collection materials in a dynamic environment (p. 3). Experiments run by the IPI (2012) indicate that sustained high temperatures are more of a risk than sudden spikes, and, similarly, that the sustained highs and lows of summer and winter, respectively, represent more danger to materials than more intermittent or temporary swings (p 15).

Temperature ranges in UASC storage spaces all exhibited mean and median temperatures around 70 degrees, and tended to be largely consistent outside of the temporary fluctuations

noted above. The temperature is at the higher end of the recommended range, due in part to staff comfort since workspace and collection storage often coexist in the library. Taken on its own, temperature does not appear to be of great concern in UASC spaces. It is also the more easily controlled of the measured parameters. However, consideration of the temperature in concert with relative humidity points to clear issues in management of the moisture level in UASC storage spaces.

The more specialized analysis provided by the application of the IPI's preservation metrics is meant to assess risk on a continuum, by looking deeper than variation from a single recommended value for temperature or humidity. Applying these metrics to the year's data is unambiguous in its assertion of risk for UASC's storage spaces. Three of the monitored locations registered risk warnings in all four of eClimateNotebook's Preservation Environment Evaluation categories; the other two locations registered risk warnings in three categories.

The Preservation Environment Evaluation categories identified by eClimateNotebook's analysis use ratings of *Good*, *OK*, and *RISK*, to provide indications of risk for each metric as follows:

Natural aging, which indicates the risk of an artificially accelerated rate of decay to organic materials, is measured by the Time-Weighted Preservation Index (TWPI). The TWPI assigns a single, time-weighted measurement meant "to condense a whole period of changing temperature and RH conditions into one value" (Nishimura, 2011, p. 4).A TWPI of 75 - 100 is ranked as *Good*, 45 - 75 simply *OK*, with anything given a rating of *Risk*, indicating a poor environment with a risk of accelerated aging.

Figure 2 shows the TWPI measured for each of the UASC spaces. Each measurement fell in the IPI's *Risk* range. Though all were relatively close to the 45 value that marks the lower end of the *OK* range, the *Risk* rating across all spaces indicates a consistent potential for accelerated aging and decay for UASC collection materials, no matter where in the building they are stored.

Figure 2

GOOD: TWPI > 75	**OK: TWPI 45 - 75**	**RISK: TWPI < 45**

Location	**TWPI**
North Storage	38
Special Collections	43
UASC East	38
UASC West	38
Vault	44

Mechanical damage assesses the potential risk of physical, non-chemical deterioration of hygroscopic (water-absorbing) materials (e.g., wood, textiles, and paper) brought on by dimensional change in shape or size resulting from an overabundance or lack of absorbed moisture. This risk for mechanical damage is measured by the Equilibrium Moisture Content (%EMC) and Dimensional Change (%DC). %EMC values represent the "percent by weight of water" of hygroscopic materials, using estimates of maximum and minimum absorbed moisture content. The %EMC is assessed alongside the Percent Dimensional Change (%DC), an estimate of the changes in size of an object caused by absorbed moisture.

Figure 3 provides the statistical values for the *Good*, *OK*, and *Risk* for %DC and %EMC, as well as the values for each UASC location monitored. %EMC results varied across the five locations, but only the Special Collections room and Vault received *Good* or *OK* ratings for both metrics. The %DC values were more consistent, with each space garnering a *RISK* rating. This indicates that while materials in some UASC storage may not get overly dry or damp, the amount of fluctuation in physical size brought on by moisture absorption leaves hygroscopic materials in all spaces at risk for physical damage.

Figure 3

GOOD: Min %EMC ≥ 5 AND Max %EMC ≤ 12.5 AND %DC ≤ 0.5	**OK: Min %EMC ≥ 5 AND Max %EMC ≤ 12.5 AND %DC 0.5 - 1.5**	**RISK: Min %EMC > 5 OR Max %EMC < 12.5 OR %DC < 0.5 OR %DC > 1.5**

Location	**Min %EMC**	**Max %EMC**	**%DC**
North Storage	5.2	15.1	2.77
Special Collections	5.5	11.2	1.59
UASC East	4.8	13.9	2.52
UASC West	4.8	13.9	2.52
Vault	5.3	11.8	1.79

Mold risk is the most straightforward of the IPI preservation metrics, simply measuring the potential for mold growth on any organic materials. The Mold Risk Factor (MRF) uses an analysis of temperature and relative humidity measurements to predict the likelihood of mold germination on collection materials. An MRF of less than .5 is considered *Good*, with minimal

risk of mold; any reading above .5 indicates that any mold spores present will have germinated, and that mold may be actively growing on collection materials.

Figure 4 illustrates why mold risk represents a concerning metric for UASC storage spaces. Due to the duration of periods of high humidity, three of the five monitored locations are at high risk for mold growth, including both in the UASC storage stacks (the primary storage location for collection materials). While identified mold growth on UASC collection materials to date has been rare and largely contained in a few specific boxes or folders, the magnitude of the MRF calculations for the UASC stacks and North Storage areas is indicative of a problem that is far beyond IPI's identified threshold for likely mold growth.

Figure 4

GOOD: MRF ≤ 0.5	**RISK: MRF > 0.5**

Location	**MRF**
North Storage	1.77
Special Collections	.04
UASC East	1.33
UASC West	1.17
Vault	.06

Metal corrosion assesses the risk of corrosive damage to metal materials or components, and is measured using the same maximum Equilibrium Moisture Content (%EMC) value that contributes to the mechanical damage metric above. For this metric, *Risk* is indicated at any reading over 10.5%, which translates to sustained period of high relative humidity.

Figure 5 presents a pervasive risk of metal corrosion in all UASC storage spaces, with the highest risks in the north storage area and the main UASC stacks. Materials with metal components are not common in UASC's collections, and we are not aware of significant holdings utilize metallic inks, so the consistent risk across UASC storage spaces, while concerning, is not as immediate a threat to UASC collections as some of the risks noted above.

Figure 5

GOOD: Max %EMC < 7	OK: Max %EMC 7 - 10.5	RISK: Max %EMC > 10.5

Location	TWPI
North Storage	15.1
Special Collections	11.2
UASC East	13.9
UASC West	13.9
Vault	11.8

V. Potential Future Activities

While truly addressing the temperature and humidity based concerns in the preceding analysis would likely require replacement or overhaul of Galvin Library's aging HVAC system, there are more immediate changes that UASC staff can make based on this information. Analysis of the metrics for the different storage spaces results in some clear directions that UASC will endeavor to implement over the coming months to best protect and preserve our collections:

Discontinue UASC use of North Storage: The North Storage space was not the only storage space monitored to be ranked in the Risk category for each metric. However, it is not realistic at this time to physically remove all materials from the UASC stacks, being that this area represents our primary collection storage area and it is directly adjacent and open to the University Archivist's desk and the UASC reading room. The North Storage space, however, is not a primary storage space, instead serving as some combination of a staging area for potential Special Collections material identified from the library's general collection and a longer-term home for material historically considered candidates for special collections. While North Storage was recently considered as the location for Special Collections stacks, it is clear that UASC should abandon the area entirely, as environmental conditions there make it unsuitable for the storage of rare, valuable, or unique collection material.

Reassess what is stored in the vault: The storage room colloquially known as the vault does not, as the name might suggest, house the most rare or valuable items in UASC's collections. The majority of the vault is taken up by one of UASC's Institute of Design collections, a much used collection of unique student and faculty work and other primary documentation of ID's history. However, many other collections and three-dimensional artifacts currently stored in the vault are there due to their physical size and/or format, meaning that valuable space in one of the rooms that scored highest on the IPI metrics is taken up by material that is not especially at risk or valuable to researchers of Illinois Tech's legacy. The proximity of the vault to the UASC

reading room also means that at-risk but high demand items could be stored there with a minimal impact on staff and/or patron convenience.

Use the Special Collections room for archival material: At present, UASC is in the process of identifying and moving library material that meets the Special Collections inclusion criteria approved by the library's management team. There is still ample space in the room, however, for other material, and the datalogging and analysis has indicated that this is one of the more environmentally stable rooms at UASC's disposal. While retrieval of archival materials from this room would be more onerous and time consuming than the UASC stacks or the vault, UASC could easily identify high value or especially at-risk material to move to the Special Collections room based on rate of use and existence of digital or analog surrogates. Archival materials that are not often used or for which UASC prefers to serve surrogates (for reasons of fragility or convenience) could be stored in the Special Collections room with little impact on patrons or archival staff.

Explore dehumidification. A dehumidifier was used in the UASC stacks for a number of years, but its use was discontinued in approximately 2017. The amount of water generated by the dehumidification process required daily removal, even when using an industrial sized garbage bin, and staffing at the library meant that the dehumidifier had to be shut off at certain times in the evening to avoid overflow and spillage when library staff would not be present to empty the bin the next morning. This meant that each weekend, the relative humidity rebounded towards more natural levels, which tended to create just the sort of dramatic variance that the dehumidification was implemented to prevent. UASC staff could possibly revisit this model to determine if there is a feasible way to dehumidify the UASC stacks without introducing undue fluctuation in relative humidity levels due to lower staffing levels on the weekends. It may be determined that the overall consistency in relative humidity is of great enough value that weekend fluctuation might be an acceptable drawback of an otherwise beneficial humidity mitigation effort.

VI. Conclusion

A lack of proper environmental control in UASC spaces was anecdotally known, but this grant provides clear delineation of specific risks in particular spaces. The environmental conditions that are pervasive in UASC spaces and the risks that result from these conditions are in clear opposition to UASC's role in preserving the unique, primary source materials that tell the story of the university and its legacy.

Wholesale replacement of the library's HVAC system or comprehensive modernization and improvement of the library's building envelope would likely not be feasible in the short- to middle-term, and any action taken by UASC in lieu of these activities will not be able to completely ameliorate the environmental issues at hand. However, UASC and Galvin Library will use this data to guide our internal activities and decision making as well as our discussions with campus partners to determine potential improvements to the library's air handling system.

Works Cited

Image Permanence Institute. (2012). *IPI's Guide to Sustainable Preservation Practices for Managing Storage Environments*. (Vers. 2). Image Permanence Institute/Rochester Institute of Technology.

Nishimura, Douglas W. (2011). *Understanding Preservation Metrics*. Image Permanence Institute/Rochester Institute of Technology. Retrieved July 21, 2020 from https://s3.cad.rit.edu/ipi-assets/publications/understanding_preservation_metrics.pdf