LINDA BLASER AND SUSAN M. PECKHAM
DISCUSSION GROUP CO-CHAIRS

The Archives Discussion Group 2008: Sharing Information about Environmental Monitoring

Susan and I wanted to bring together a group of experienced professionals to discuss the pros and cons of various environmental monitoring systems. We wanted to learn about which monitoring systems worked best in different situations. The panel we brought together included:

Rachel Perkins Arenstein
Conservator in Private Practice
(Rachel also presented for Samantha Alderson, American Museum of Natural History, New York)

Barbara Brown and Jane Boyd
Head of Photo Conservation and Assistant Paper Conservator
Harry Ransom Center, University of Texas at Austin

Joan M. Brink
Conservation Liaison, Dept of Preservation & Collection Maintenance
Cornell University

Eliza Gilligan
Smithsonian Libraries

Nancy Lev-Alexander
Head, Preventive Conservation Section
Library of Congress

Vasare Rastonis
Columbia University Libraries

Emily Kaplan
Smithsonian National Museum of the American Indian

We had several questions we presented to our panel in preparation for our discussion. Questions included:

- What type(s) of environmental monitor(s) do you use?
- What do you like about the system you are using?
- What don't you like about the system you are using?
- Can you relay any lessons learned?
- Beyond the conservation staff, who else at your institution understands the concept, the data, and the system you are using?
- Have you used your system in an effective way to address environmental problems at your institution? If so, please explain.
- Have you developed any unique applications to monitor special items in your holdings?
- Have you encountered any resistance to environmental monitoring? If so can you explain why there was resistance and how you have worked to counter that resistance?
- How large is an average sized archival storage space in your facility and how many monitors do you place in the space? Do you have a strategic plan for monitor layout?
- Do you use monitors in other spaces, e.g. exhibit hall, processing room, research room, and conservation lab?
- How often do you calibrate the loggers and how do you accomplish this task?
- How does cost affect your equipment decision?
- Does size play a role in your equipment decision? If so, in what way?
- How many people are charged with this task at your institution? How large is your institution?

This open discussion took place on April 24, 2008, during the AIC 36th Annual Meeting, Denver, CO. The moderators organized the panelists, led the discussion, and recorded notes. Readers are reminded that the moderators do not necessarily endorse all the comments recorded and that although every effort was made to record proceedings accurately, further evaluation or research is advised before putting treatment observations into practice.

RACHAEL PERKINS ARENSTEIN

SO MANY OPTIONS, HOW DO I CHOOSE?—THINGS TO CONSIDER WHEN SELECTING A DATALOGGER

There are lots of great dataloggers, which makes it difficult to choose one specific product. The best way to choose which logger to use is by evaluating your needs.

Question 1: Do you actually need dataloggers?
Hygrothermographs remain readily available and, assuming that they are properly cared for, can provide years of service. Dataloggers allow the user to set sampling intervals. Dataloggers' electronic sensors are more durable and respond faster than hair hygrothermographs. Unlike hygrothermographs, dataloggers generally do not require frequent calibration. Some dataloggers are cheaper than hygrothermographs. Ultimately, the greatest advantage of dataloggers over hygrothermographs is the ability to easily analyze the data. If data analysis is not necessary and you just need to walk by your unit and check the environmental conditions—then you can stick with a hygrothermograph.

- Datalogger advantages include
  - User set sampling intervals
  - Quicker response times for electronic sensors
  - Less frequent calibration
  - Can be cheaper
  - Increased ability to analyze data

Question 2: What is your budget?
Everyone's goal is to get the best value, meet the needs of the institution, and stay within budget. The price of the unit generally reflects the quality of the sensor, the longevity of the battery, the durability of the casing, the flexibility of the software and any additional features such as displays or alarms. Some of the necessary accessories cost extra. There are situations where an inexpensive logger can be appropriately utilized such as when you want to capture data in multiple locations and extra features are less important.

- Unit price reflects
  - Sensor quality
  - Battery longevity
  - Casing durability
  - Software flexibility
  - Additional features
  - Displays
  - Alarms
- Extras
  - Software
  - Cables
  - Probes

Question 3: What are you monitoring?
There are two broad monitoring categories although they are not mutually exclusive. *General trend* logging is done to develop an environmental profile of a particular space. This profile is established by capturing data over a long period of time, which means that the logger must be reliable, have lots of memory and a long battery life. For special short term projects, such as exhibits or temporary storage spaces, other factors may come into play such as size, LCD display or alarm capability.

- General trend logging
  - Reliability
  - Memory
  - Battery life
  - Real-time/networking?
- Project oriented logging
  - Accuracy
  - Size
  - Display
  - Alarms
  - Real-time/networking?

Question 4: Do you need real time data collection capability?
If your building has a Building HVAC Management System, ask for access to the system so that you can monitor the system in real time. If that type of system does not exist, it can be expensive to add. Real time data collection is beneficial when there are so many monitoring points that downloading data becomes labor intensive. This type of system can also facilitate data collection from off-site storage facilities.

- Pay a premium
- Useful for
  - Off-site storage
  - When large numbers of loggers are involved
  - Proven history of collection vulnerability
- Utilize existing HVAC Building Management System

Question 5: How do you assess datalogger features?
It can be challenging to evaluate different loggers in relation to each other because each manufacturer writes their products specifications differently.

- Memory Capacity: The total number of readings that the logger can hold—on how many channels.
- Battery Life: At a minimum, a logger should have battery life substantial enough to provide one full year of monitoring but you must check with the manufacturer to ensure that a logger with a one year battery life will actually achieve that if the logger is set to take frequent readings. It is critical to know whether or not the logger saves the data if the battery dies.

- Sensor range and accuracy: A logger calibrated at three points across its range should take accurate high and low readings, while a logger calibrated at one midpoint closer to ambient temperature may not be accurate at the extremes. It is important to determine if the application requires accuracy within 0.5% or 5% RH, and note how accurate the system is required to be to suit the needs of your institution.
- Size, appearance and construction: Will it fit in the assigned space? Will it detract from the exhibit? Is it sturdy?
- Visible display, alarms and probes: While extremely useful for certain projects but these features generally increase cost and decrease battery life.

Question 6: What else should you consider?
- Download speed and options: Portable download units, infrared downloading and speed are all extra features to consider.
- Calibration: Can you calibrate the logger yourself or do you need to send it back—at what cost?
- Software: Ask to see a trial version to determine how easily you can start and stop logging, print graphs or generate statistics. If you are using a Mac—check to see if the software is compatible or available.
- Customer service and technical support: This is important because companies go out of business, software becomes outdated as platforms are upgraded, and products are discontinued. Ask for a free 30-day trial if you are planning to make a major purchase.

Environmental monitoring is a means to an end. Ultimately it is how you use your data and work with your colleagues that will ensure good environmental conditions for your collections.

SAMANTHA ALDERSON
DATALOGGER USE AT THE AMERICAN MUSEUM OF NATURAL HISTORY

An overview of logger use in the Anthropology Conservation lab of AMNH with special attention to ACR SmartReader loggers which can be connected to a network and calibrated by the user. (Also discussion of using salt chambers to check accuracy of datalogger RH sensors.)

Overview
The lab first purchased dataloggers in 1996. We now have 80 loggers (2008):

- 27 ACR SmartReader 2 or 2 plus
- 33 Onset Hobo Pro
- 18 Onset U12-011
- 2 PEM

Loggers are used to monitor
- Permanent exhibit halls at American Museum of Natural History (AMNH).
- Temporary exhibitions spaces at AMNH.
- Storage spaces (at AMNH and off-site).
- Conditions at traveling venues.
- Case interiors (permanent exhibit halls, temporary exhibitions at AMNH and traveling venues).
- Traveling crate interiors.

ACR Loggers
- ACRs are used for long term monitoring in the Museum and off-site storage.
- ACRs are used for more permanent installations due to long battery life, dependability, and the ability to connect them to the network.

Onset Loggers
- Hobo Pro and Onset U12 loggers are less expensive and have also proved reliable over time. They are used for temporary and traveling exhibitions.

ACR Smart Reader 2 Loggers
- ACRs can be used with an external probe, which is useful where size or visual impact in an issue, such as in a case interior or on a gallery wall when the designers want minimal intrusion.

ACR Loggers
- The ACR loggers were networked because the institution was not ready to invest in the high cost of a wireless system like Hanwell, and they already owned many ACR loggers.
- Some of the advantages of ACRs include high quality sensors, long battery life, ability to connect them to a network, and the ability to calibrate them yourself.
  - Dependable high precision sensors.
  - Long battery life (10 years or more).
  - Can add external probe.
  - USB or Serial Cable can be used.
  - Recently updated software (TrendReader 2).
  - Can be networked.
  - Can be calibrated by users.
- Some disadvantages of the ACR system is that networking requires IT support and installation fees, or personal IT expertise and perseverance. The system will not work with a large number of logging locations.
  - No wireless capability.
  - Networking has limitations.
  - Requires some tech knowledge and support.

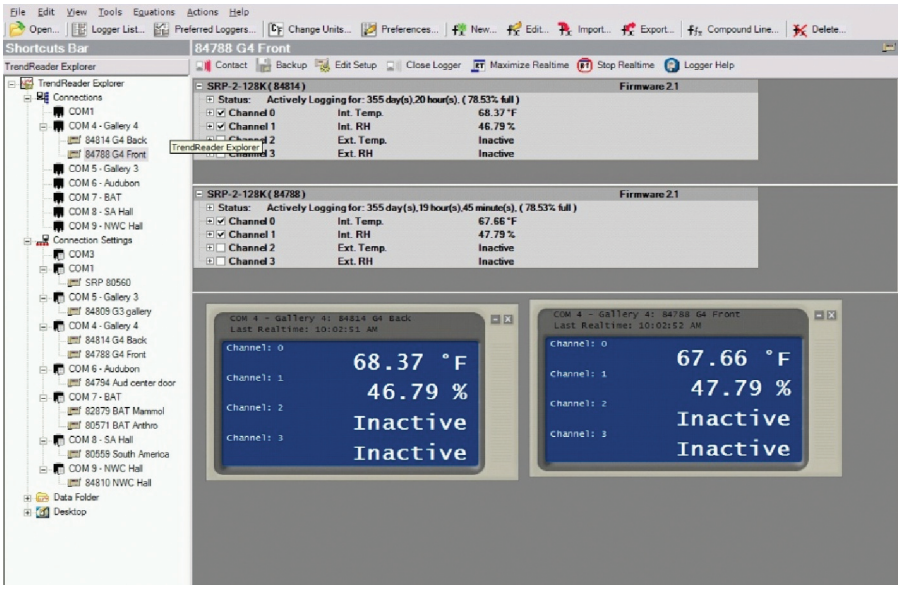


Fig. 1. Graphs can be easily customized, labeled, and saved in various formats (.CSV, .JPG, .PDF) for exporting or sending as an e-mail attachment

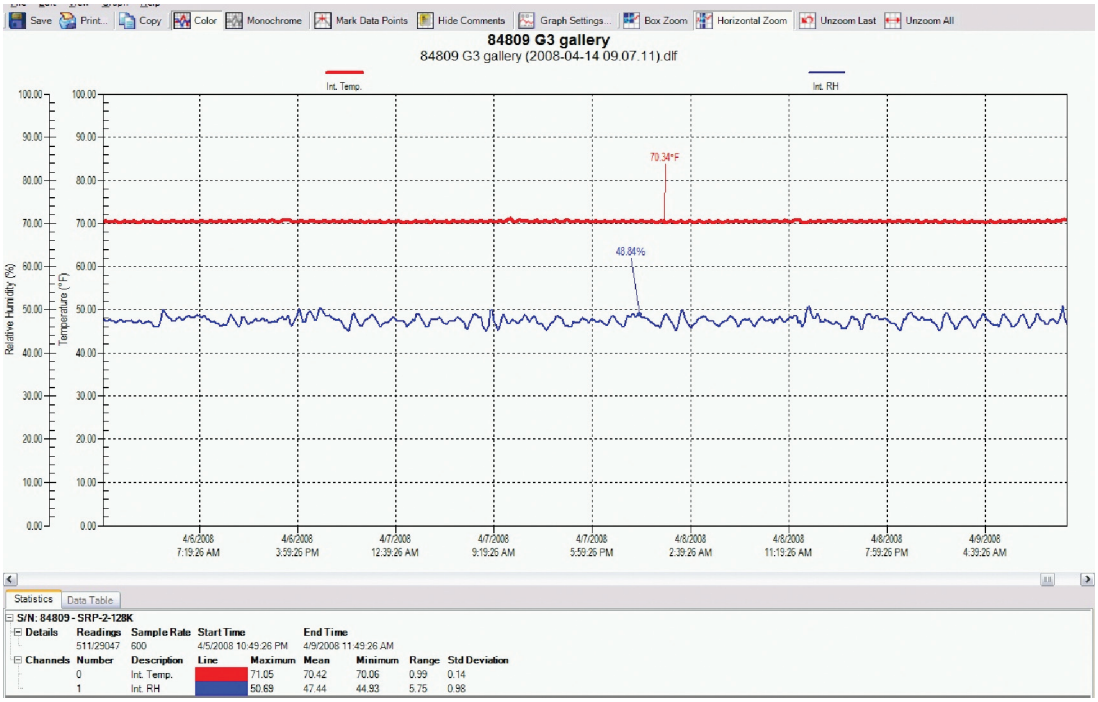


Fig. 2. You can download data from the loggers at anytime. The resulting graphs are easy to customize, print, and e-mail. Also data can easily be exported to Climate Notebook or other programs

Networking ACR Loggers

- A server device transfers data to the network. We use one box per gallery or storage space. Up to ten loggers can be connected to one device. The server device requires a power source and a network jack.
- The loggers are connected to the server box and each other with a series of adaptors and Telco cables. The cables can be long so that loggers can be far apart and you can separate the first logger in the chain from server box. This way the "messy" wires, adaptors and server boxes can be hidden behind gallery walls or in adjoining spaces, with only the logger or probe visible in the space itself.

TrendReader 2 Software—Networked Loggers

- At AMNH we currently have 6 server boxes in place with 1–2 loggers attached to each. Five are in galleries on-site, one is an off-site storage location.
- All of the loggers can easily be checked from any other networked computer in the museum that is set-up to access them.
- The software allows you to leave "real time windows" open on your desktop, to monitor conditions throughout the day as necessary.

(See figs. 1–2)

Calibration

- RH sensors can drift over time and have a limited lifetime. It is very important that the accuracy of RH sensors be checked on a regular basis. Since the companies charge significant fees for recalibration it pays to be able to check them yourself before sending them in for regular servicing.
- Salt chambers are easy and inexpensive to set up.
- Salt chambers are used at AMNH to check loggers over time and also when they first arrive to make sure they are functioning properly before they are used.
- The chambers are reported to have limited accuracy but if you run several loggers and logger types at once for cross comparison, it can be a very reliable tool.
- This is the simple system used at AMNH.
  - Saturated salt solutions that hold specific RH levels are placed in small well sealed plastic containers. The lids of the containers are fitted with a Gortex window that allows vapor exchange but prevents liquid spills and salt migration.
  - This small container is then placed in a larger container that can hold several loggers.
- Data from salt chambers can be used to check accuracy of any type of logger and can be used to recalibrate ACR loggers.
  - The calculated high and low values are entered into the ACR software to calibrate the logger.

Even if you are not going to calibrate loggers yourself the salt chambers are a simple and inexpensive way to periodically check logger accuracy.

JANE BOYD AND BARBARA BROWN

ENVIRONMENTAL MONITORING EXPERIENCES AT THE HARRY RANSOM CENTER UNIVERSITY OF TEXAS AT AUSTIN

Types of environmental monitors (loggers) used:

- HOBO model H08–004–02–20 currently in use
  - Source: Onset Computer Corporation
- PEM (Preservation Environmental Monitor)—5 units in use
  - Source: Image Permanence Institute

Strategic plan: locations of the monitors are mapped on floor plans of building to help us track conditions in the four vertical quadrants of building (each served by one air handler); although all four quadrants are not necessarily covered on each of the floors. We are monitoring collection storage areas as well as gallery spaces.

HOBOs

- Smaller sized monitors
  - Allow for flexibility of placement
  - Unobtrusive
    - Exhibit Galleries
    - Special Collections Rooms
    - Display Cases
    - Back-up units
      - Can easily be used to replace other units that are temporarily out for repair.

Monitoring the Nitrate Vault

- Exterior of the vault (which has is own air handling system)
  - Recording Hygrothermograph which includes a digital readout of the temperature and Relative Humidity levels.
- Interior of the vault
  - A HOBO is mounted inside on the interior wall.

Downloading Data

- HOBO Shuttle
  - A cable links the HOBO Shuttle to the logger.
  - When the download is complete the green "successful" light shines on.
- Download Complete
  - Once disconnected from the logger, the Shuttle lights will indicate the status of the battery life.
- Save File
  - Each HOBO data file is saved as a .txt file and then imported into the appropriate Climate Notebook

Software (CNB) file. (PEM data is downloaded directly into Climate Notebook.)
- Climate Notebook
  - Several Report options are available from CNB.
  - The Engineer's Report is useful.
    - Graphically illustrates when the temperature and Relative humidity levels are within range.
    - Provides the percentage of time that the temperature and relative humidity levels are within tolerance.

Systems Pros
- Both Allow
  - Custom setting of data collection intervals.
    - Custom setting amount of time during which data can be collected (e.g. 3 months or more).
- CNB Software
  - Data management and evaluation capabilities.
  - Ability to track and compare indoor and outdoor data.
  - Useful graphic presentation of information.
- Good Technical Support Services
  - Image Permanence Institute for PEMs and CNB.
  - Onset for HOBOs.

System Cons
- Report printing problems
  - Charts may not print properly.
  - May be due to incompatibility of equipment (an in-house issue most likely: occasional computer / printer program communication glitches).
- Not email friendly. (Since the time of the presentation, we have learned much more, and this is no longer a problem. The charts can be easily saved as .pdf files and sent as attachments to an email.)

Lessons Learned
- PEM
  - Track battery changes and other maintenance information.
  - Track move dates and locations.
- CNB
  - Keep hard copies of charts and notes for each location/monitoring device.
- Organizing Data
  - Organize by location or area monitored then include device name or number.
  - Organize files on your computer by year to make it easier to find.
- Paper Log Book
  - Download dates
  - By Whom
  - Action
    - Location/Device
    - Collect data
    - Chart made /date
    - Chart published /date
    - Notes (e.g., maintenance information)

JOAN M. BRINK
ENVIRONMENTAL MONITORING AT CORNELL UNIVERSITY

Cornell has one storage facility. The temperature range is 65–68° F and the Relative Humidity range is 35–45%.

Hygrothermographs used by Cornell from 1985 until the late 1990s
- Maintenance costs were high.
- Hygrothermographs are made by various companies but all work on the same basis, the temperature and relative humidity levels are marked on charts by the hour and the day. The charts needed to be replaced on a weekly basis.
- Parts such as hair bundles and pens also need frequent changes, and could cause record keeping problems.
- Sling psychrometers were needed to calibrate the hygrothermographs on a continuing basis.

Dataloggers
- Availability of electronic sensors to replace the hygrothermographs.
- Cornell chose the ACR Dataloggers, supplied by the Cascade Group, Oyster Bay, NY.
- In 1992 a datalogger with internal electronic sensors was produced which enclosed the humidity probe within the unit.
- A laptop computer was used to download information in the field, which is then transferred onto a desktop computer. Charts are edited using ACR software, converted for uniformity and then distributed curators, and other appropriate staff.

Internet Dataloggers
- ACR Dataloggers were time consuming.
- Did not provide real time data.
- Cornell began investigating web-based dataloggers.
- Pinnacle Technology was willing to built a prototype, once successful, Pinnacle moved into production.
- Six Pinnacle, Internet Datalogger/THR units were successfully used at Cornell.
- "Original" Internet Datalogger/TRH is no longer available as some of its parts are now outdated.
- Telnet—If you wish to test a telnet session with the online ID/TRH, call Jim at Pinnacle Technology (785–832–8866) for a login name and password.

- Pinnacle is currently redesigning the unit, and they expect release to be September 2008. No price change is anticipated. The base price is currently $675, or $750 with extra sensors.
  - No special software is needed.
  - Accessible from anywhere in the world via the Internet.
  - Works in real time.
  - Visible digital display of readings.
  - Visual online graphing.
  - Easy downloads.
  - Compatible with Excel for graphs.
  - Email alarms.
  - Machine generated "trouble tickets" sent via email using predetermined notification list which is setup individually for each unit.

Internet Alarms

The alarm setup, in fact all other setups, can be individualized to suit your individual needs. This is the setup screen as seen through Tera Term (a free software system).

ID/TRH login: user
ID/TRH password:
ID/TRH /> alarms
1) Upper temp limit: 75 deg. F
2) Lower temp limit: 50 deg. F
3) Maximum temp change: 10 deg. F
4) Upper RH limit: 65%
5) Lower RH limit: 25%
6) Maximum RH change: 10%
7) Aux. Sensor Alarm: Off
8) Aux. Sensor String: No Sensor
9) Alarm Hold Time: 5 min
10) Alarm Repeat Time: 0 min
11) Email for alarm: jmb7, beb1,
12) Exit

Sample Report: MailDumps

ID/TRH /> maildump
Samples are available from 2/3/07 to 4/9/08
Enter the latest date required [4/9/08] 3/31/08
How many days would you like to dump? [all] 1
Enter the email address: jmb7@cornell.edu
Sending samples to jmb7@cornell.edu...
Connecting to appsmtp.mail.cornell.edu:25...
Connected to mailserver - Press enter <cr> to cancel

Comes through email as:
Date: Fri, 4 Apr 2008 11:36:47 –0400 (EDT)
From: CLStest@cornell.edu
Subject: CLStest data dump

Timestamp,Date,Time,Temp,RH,Flag:
04338690,03/31/08,23:30,074,027,0
04338660,03/31/08,23:00,075,026,0
04338630,03/31/08,22:30,076,026,0
04338600,03/31/08,22:00,075,026,0

Data is compatible with Microsoft Excel. Simply open Excel and then open your text file using Microsoft Excel. Microsoft Excel enables you to produce a chart or file. According to IPI (Image Permanence Institute), RIT, Rochester, NY, this data is also compatible with Climate Notebook.

(See figs. 3–4)

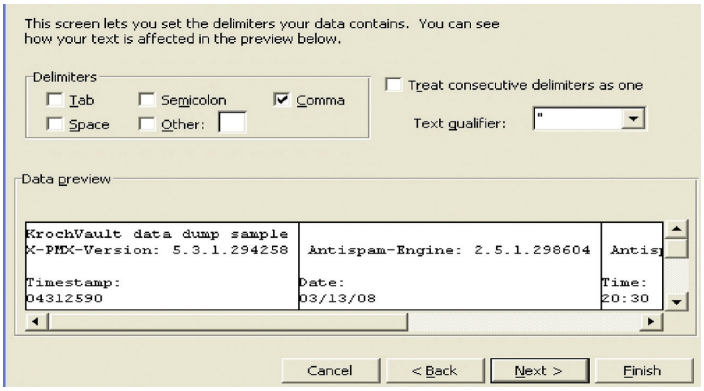


Fig. 3.

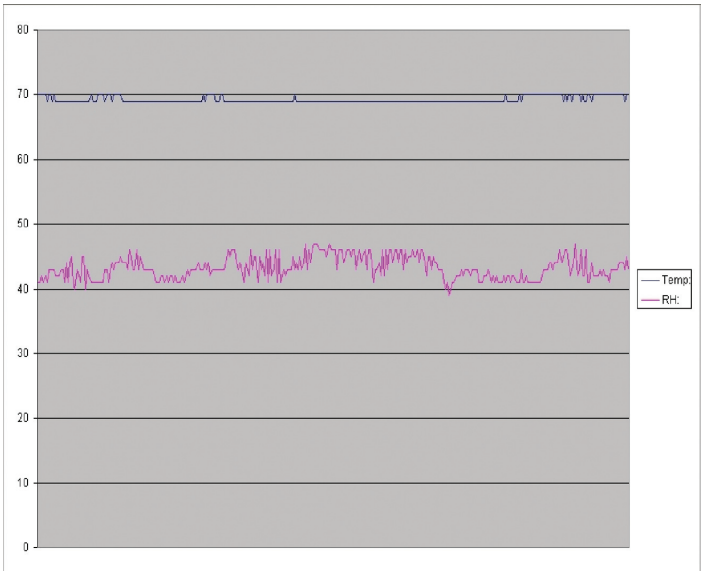


Fig. 4.

ELIZA GILLIGAN

SMITHSONIAN INSTITUTION LIBRARIES; HYBRID APPROACH TO ENVIRONMENTAL MONITORING

Monitoring locations

- We monitor temp/RH in our special collections storage areas on a weekly download basis (4 locations in DC, and 1 in NYC).
- We monitor other locations on an as-needed basis.
  - Exhibit cases (1).
  - Areas affected by National Museum of American History renovation (2).

Our Needs

- Collect accurate temperature and Relative Humidity data.
- Need both remote and on demand access.
- Ability to retain data.
- Ability to share data with library and facilities staff throughout the Institution.

Loggers We had Tried…

- ACR dataloggers, which worked but were over 10 years old and used a DOS operating system.
- Hanwell, tried but it did not work in NHB
- Climate Notebook & PEM's
  - Software great; monitors require ram card download.

Developing the Hybrid Approach

- Use Climate Notebook (CNB) for all data graphing and presentations.
  - Superior graphics, very easy to email to facilities staff as a .PDF file.
- ACR data uploaded to Excel (in order to convert data to .csv format), then CNB to produce graphs.

Replacing the ACR

- Heard about the web based Pinnaclebeing used by Cornell University at the American Library Association meeting.
- Looked on website www.dataloggerstore.com and found some other options including Newport iTHX-M.

Pinnacle vs. Newport

- Pinnacle was easy to install and use, had good tech support, was developed for the library community, but had no battery back-up.
- Newport- not developed for the museum, library, archives community, was much more complex to configure, but included more functionality (such as a battery back-up, email alarms, and use of a flash memory card).
  - Ethernet connection.
  - Flash memory card slot.
  - Can be wall mounted.
  - Probe comes in different lengths.
  - LCD display of data.
  - AC power cord.

(See figs. 5–7)

NANCY LEV-ALEXANDER

ENVIRONMENTAL MONITORING AND MANAGEMENT AT THE LIBRARY OF CONGRESS

Monitoring Objectives—A successful monitoring program begins with clear objectives

- What's Possible
  - Determine best possible storage/exhibit climates based on collection need, mechanical system capability and collateral factors such as human comfort where relevant.
- What's Wrong
  - Collect and analyze data to locate the source of mechanical problems.
- What Needs Attention
  - Analyze data to assess collection risk and to prioritize preservation actions and resources.

Equipment Used

We do not rely on the fixed building sensors as their maintenance is not under our control nor is the data easily uploaded in batches into Climate Notebook.

- Preservation Environmental Monitor (PEM)
  - 120 PEMs deployed in 3 Capitol Hill Buildings and 3 offsite locations.
  - (Architect of the Capitol manages over 100 fixed sensor sites throughout 5 Library buildings).
- Climate Notebook ®Analysis Software
- MyClimateData: The Collections Storage System
  - Web-based application created to collect, organize, analyze risk and share many types of collection information including environmental data, floor plans, photographs, notes.
  - www.imagepermanenceinstitute.org
  - Myclimatedata is a new application that IPI created for the Library which we intend to launch towards the end of this summer 2008.

Benefits

Our facility is large but onsite manual downloading is still very feasible. We use the CNB compare notebooks feature frequently to look at an indoor climate in relation to outdoor conditions. We also compare current data to past performance in the same space or spaces with theoretically similar mechanical capabilities.

Fig. 5. Online availability of data, either real time or archived graph

Fig. 6.

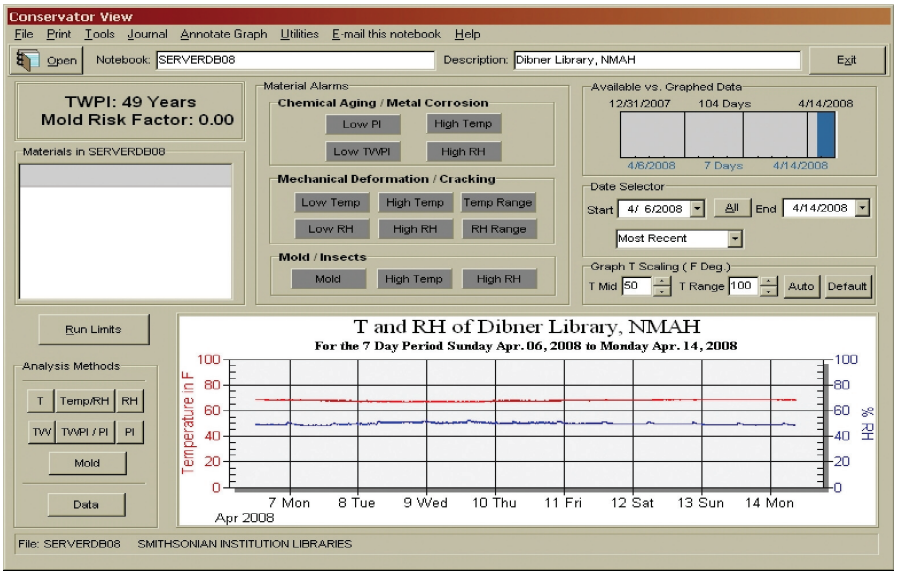


Fig. 7. Climate Notebook Conservator's View

- PEMs
  - Easy to install and operate.
  - Portable therefore flexible.
  - Accurate / IPI performs will calibrate units.
  - Easy to remedy problems without losing data.
  - Requires regular site visit to collection spaces for downloads.
- Climate Notebook®
  - Allows data to be manipulated in many ways.
  - Allows spaces to be compared including outdoor data.
  - Analyzes and displays data by temp, RH, dew point, Preservation Index, Equilibrium Moisture Content.

(See figs. 8–10)

Drawbacks

Even the new PEM II costs a few hundred dollars which can be prohibitive, although well worth the expense. Anyone in the conservation/preservation profession should be capable of mastering Climate Notebook but its complexity may not be suitable for a small cultural institution particularly.

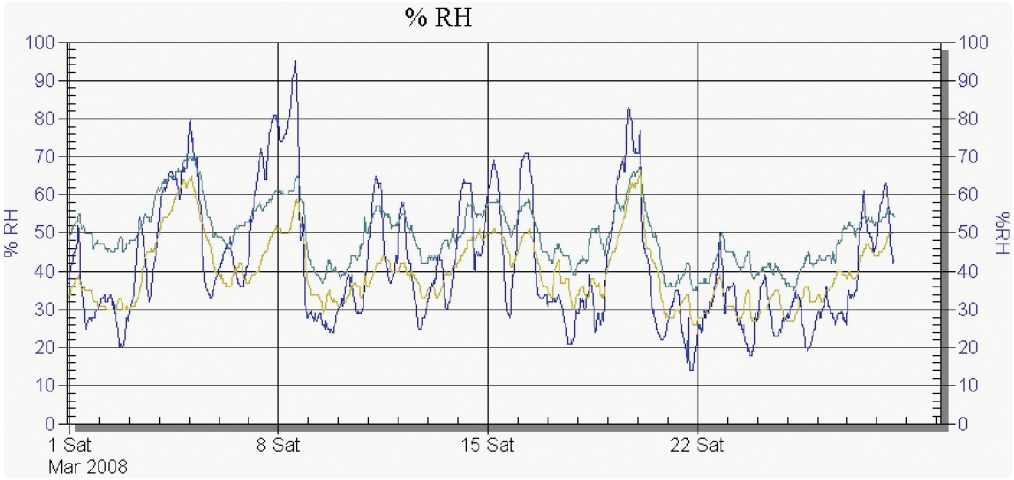


Fig. 8.

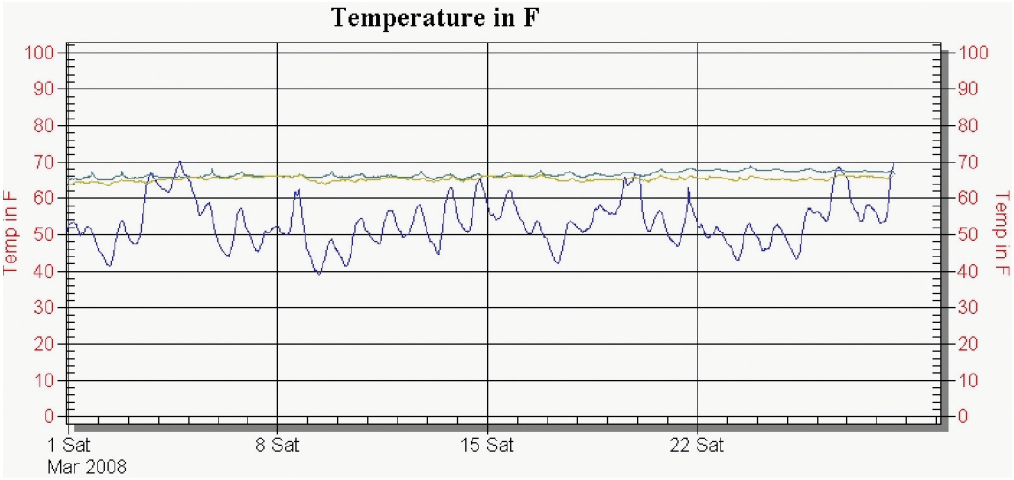


Fig. 9.

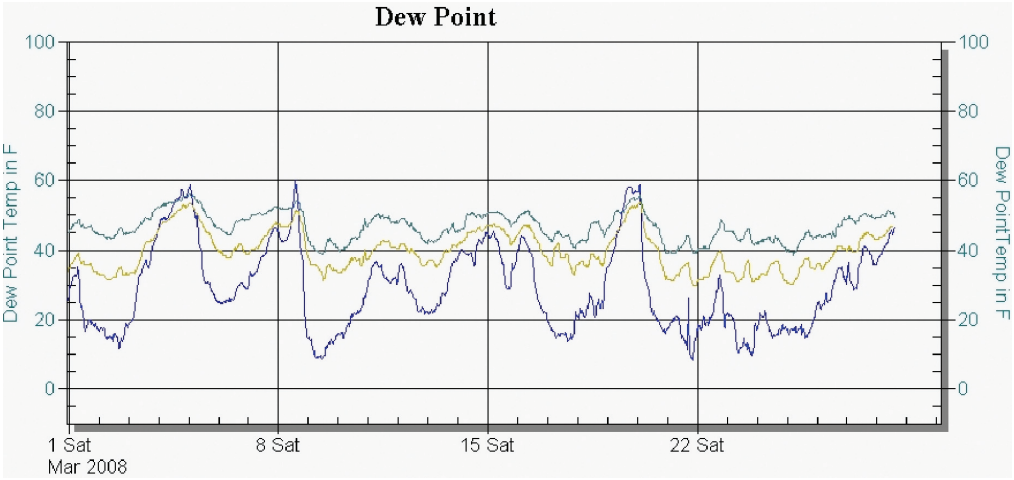


Fig. 10.

- PEMs
  - Not inexpensive.
  - PEM I SRAM Cards have limited memory and require card reader.
  - (PEM II uses standard flash drive to collect data).
  - Requires onsite downloads.
- Climate Notebook®
  - Requires time and attention to learn software.

Lessons Learned

We have several vaults and exhibit cases with independent HVAC equipment that if malfunctioning can produce heat without cooling. These spaces can become very warm—above 80F—within a day. I believe that built in equipment shutoffs are more immediately reliable than alarms but your monitoring strategy should reflect specialized concerns. In a larger strategic sense we are focused on the long term both in our investigations and in our approach to remedy problems. Like most institutions LC facility staff has many balls to juggle including life safety concerns which always take priority. Every mechanical deficiency cannot be addressed at once. Conservation/preservation staff need to understand the resources and expertise available in facility departments, to prioritize, and bring forward problems with this in mind.

- Understand your objectives and priorities.
- Short term and urgent.
  - Protect specialized climates that can quickly change such as insulated vaults or cases with independent HVAC equipment through frequent and/or constant monitoring.
- Long term
  - Focus on careful investigation that leads to sustained improvements rather than quick fixes.
  - Think about how the location of monitors or sensors influences data.
  - Collect and analyze data strategically by location, season or event.
- Work collaboratively with facilities and collections colleagues.
  - You'll need to have a good relationship with facility technicians, mechanics or engineers unless you can single-handedly run your building.
  - Collection managers and staff can be the most persuasive advocates for preservation.
- Do not use environmental data as a cudgel.
  - Even well-intentioned sharing of environmental data can be taken as " I know more than you do."

Special Applications

- Monitoring conditioned exhibit case versus unconditioned case to determine effectiveness of silica gel.
- Comparing data collected from monitors in storage space against data collected from data loggers placed in return air ducts.
- Verifying effects of known mechanical adjustments such as planned shut downs or announced changes in chilled water temperature.

VASARE RASTONIS

ENVIRONMENTAL MONITORING SYSTEMS AT COLUMBIA UNIVERSITY

Dataloggers

- 14 ACR Smart Readers
- 41 Hanwell RL–2100 sensors
- 7 PEMs & 5 PEM2s

How Hanwell Works

- 41 sensors in 3 libraries collect data using Vaisala sensors.
- Data is sent in set intervals to 4 Smart receivers in the 3 libraries via radio telemetry.
- Hanwell software polls the Smart receivers for stored data.
- Data is transferred to the server at Butler Library over the network.
- Environmental data can be accessed by 15 PCs but can only be controlled by 1 PC in the conservation lab at Butler Library.

(See fig. 11)

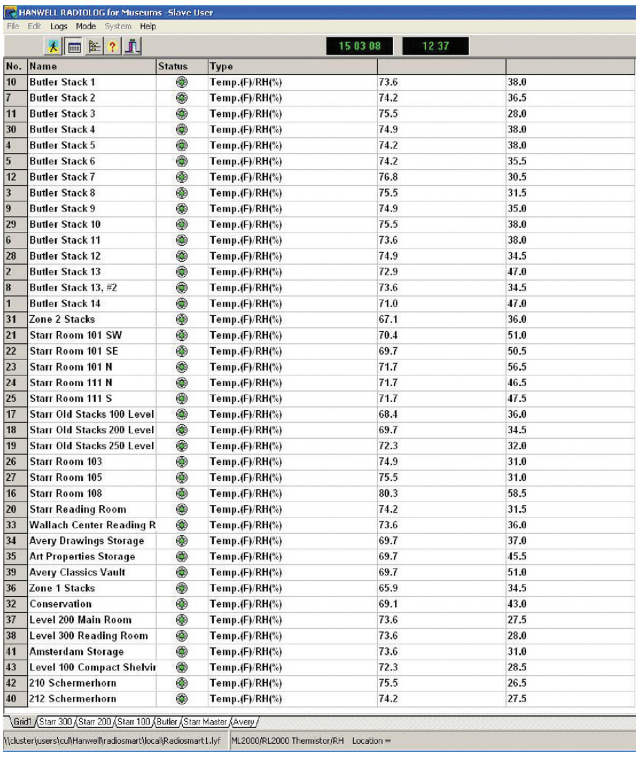


Fig. 11. "Text" view for all 41 radiologgers/sensors

Pros

- Convenient monitoring of current environmental conditions from a PC or Mac with Windows.
- Environmental data can be batch collected and backed up as .csv files—especially time saving with 41 monitored locations.
- Temperature and RH can be recorded at varying intervals (once every 5 seconds to once every 12 hours).
- Sensors can either stand freely or be mounted to a surface using Velcro or high security metal brackets.
- Sensors general properties, calibration, filters and alarms can be adjusted as needed.

Cons

- Sensors run on 9v batteries which require replacement approximately every 7–8 months for sensors with display screens and 9–10 months for sensors without display screens.
- The Conservation department does not receive support from our IT department for Hanwell software.
- With the availability of real time data, 1–2 hours a week can be spent checking the conditions and reporting to curators and facilities when problems occur.
- The sensors with display screens show temperature in degrees Celsius.
- Poor radio frequency causes alarms to show in the "text" view and spikes in data to appear in the "graph view."

EMILY KAPLAN

NATIONAL MUSEUM OF THE AMERICAN INDIAN (NMAI): HANWELL SYSTEM

NMAI has three facilities, one in New York, one in Suitland, Maryland and one on the National Mall in Washington DC. They use the Hanwell system at the Suitland and Washington facilities and Hobos at the New York facility. What follows is a summary of experiences with the Hanwell system at the Maryland and Washington facilities.

The NMAI Cultural Resources Center in Suitland, MD, which opened in 1999, is the NMAI storage and research facility. Hanwell Environmental Monitoring System (EMS) software, an Architect controller with receiver and one repeater, and eleven relative humidity/temperature radio telemetry sensors with auxiliary battery packs are used in the Suitland facility. The sensors are placed in three levels of collections storage (approximately 48,600 cubic feet), and in all collections processing rooms including conservation laboratories. Collections Management staff are responsible for monitoring the system, tracking and turning off alarms, printing out reports, and reporting any problematic environment changes to the Smithsonian Office of Facilities, Engineering, and Operations. Collections staff also compare data collected from the Hanwell system to the building HVAC system reports. This has been particularly useful when addressing unacceptable swings in relative humidity.

NMAI uses a dedicated PC in the collections storage area with an Uninterruptible Power Supply because the building has a history of power outages, which can affect data collection. Several staff members have access to the Hanwell software from their desktops using a Windows Remote Desktop Connection. NMAI also uses hygrothermographs in some areas for backup and comparison. The challenge at this time is to decide whether to invest in a system upgrade (most of our components were purchased in 1999) to attain consistency in environmental monitoring methods with our two other facilities. The EMS software has been superseded by a new software system and cannot be upgraded, which makes IT support problematic. NMAI currently does not have a service contract with the vendor. So options are being evaluated.

At the NMAI exhibit facility on the Mall in Washington DC which opened in 2004, we use a more recent version of the Hanwell software and sensors; including Radiolog software, an Architect Host Computer AR510 base station/receiver, and twenty relative humidity/temperature radio telemetry sensors with auxiliary battery packs. Some sensors are equipped with external probes. Sensors are installed in galleries, some exhibit cases, and the collections workroom. Since the sensors have probes, the sensors themselves easily can be hidden in the galleries, inside cases, and under case decks. There is no dedicated PC for this Hanwell system, it is accessible only from the Collections Manager's desktop and from a PC in the central server room that can only be accessed by the IT staff.

NMAI has had some challenges with the Hanwell system. As the museum was being prepared to open, the initial installation of hardware and software did not perform reliably for several months due to unexpected radio signal interference caused by the building structure. Although the vendor visited on site when the building was a shell to test radio reception from various floors to an internal antenna, the signals did not transmit continuously from distant corners of the galleries after the walls and exhibit cases were in place. NMAI also experienced problems with the Architect base station crashing due to initial building power outages and other problems that still sporadically happen. An additional "Bermuda Triangle" effect occurred in one display case that contained plasma screens-the Hanwell engineers have never determine why the screens interrupted the radio signal. So NMAI gave up after several months and reverted to a recording hygrothermograph inside that case.

The system is currently running with a new version of the software and two repeaters, one on each gallery floor. The main drawback, in addition to the Architect crashing, is the labor-intensive interface. The alarms require manual

data entry and authorization each time a sensor experiences a reading outside of parameter that lasts for more than 10 minutes. (The 10 minute elapsed time alarm was especially frustrating when units were reporting sporadically due to signal loss.) Another consideration is battery replacement—considerable labor and frequent access to exhibit cases is needed to change the 9 volt batteries needed by the unit. Auxiliary battery packs with 4 AA batteries are useful because they can extend the working time of the sensor, but they are awkward and bulky in part because they need electrical tape to secure the battery pack to the sensor unit. The auxiliary battery pack is not a problem in collection storage areas but can be a problem in exhibit cases due to space restrictions and aesthetic concerns.

The Collections Manager, monitors data from her desktop and can print out charts for the units in the 20–25 different locations in the galleries, storage, and cases. This is a useful tool for accountability and to use when communicating with building engineers and maintenance staff. For example, if there are unusual spikes on the charts that set off the alarm, the system notes the precise date and time which helps the engineers diagnose the HVAC malfunction. If the system goes out of parameter and is not reported by engineering night shifts, it is possible to determine who was on duty at the hour of malfunction that went undetected.

NMAI has Hanwell sensors in some cases, Arten sensors in others, and a recording hygrothermograph in one case. The Collections Manager visually monitors the displays during periodic gallery walkthroughs. NMAI also uses HOBOs in some cases for a light monitoring project, these are downloaded monthly.

LINDA BLASER

ENVIRONMENTAL MONITORING: PEM AND CLIMATE NOTEBOOK IN THE REGIONS

My experience working at both the National Archives and Records Administration and National Park Service there were several types of environments to monitor—cold storage for acetate film, cool storage for electronic media, archival storage, preaccessioned permanent records storage, and temporary records storage. Each type of record is controlled by a different set of regulations and therefore has different set points and goals. In both situations I've used PEMs to monitor those environments. PEMs are used to certify the environment in new buildings, alert staff to problems, as a basis for discussions with facility managers, used to compare microclimates and stratification within a storage space, and used to verify compliance with regulations.

Climate Notebook software provides easy to interpret reports that can be used when discussing environmental conditions with the building engineers, and the collections managers.

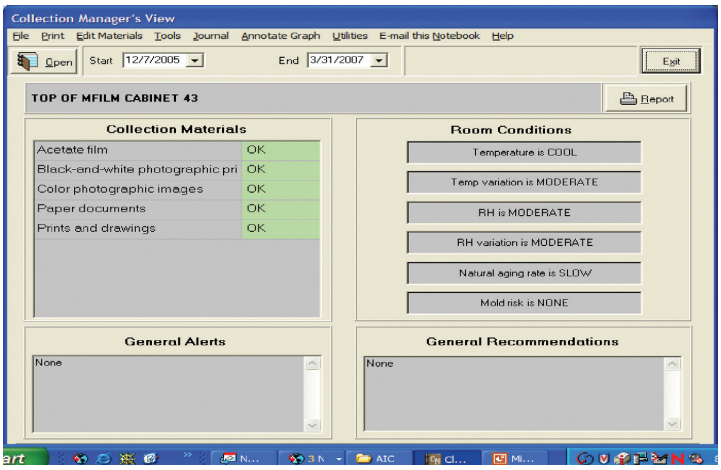
(See figs. 12–13)

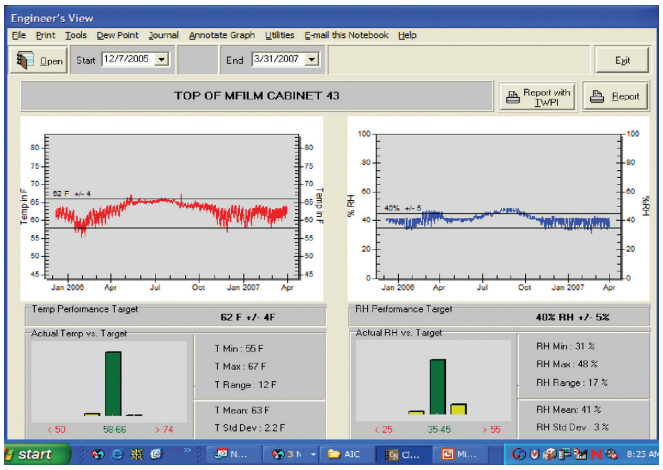
Prior to the April 2008 Archives Discussion Group, we asked several conservators who were unable to attend to contribute his or her opinions about data loggers.

ADG DISCUSSION COMMENTS AND QUESTIONS:

Contributor 1

One participant uses HOBO's because of the significantly lower price-tag and small size (easy to put in traveling exhibit cases, easy to hide). Besides having monitors placed in permanent monitoring position, additional monitors are often needed for short term projects. Having a HOBO "back-up





Figs. 12–13.

stash" fulfills those types of needs. HOBOs need more sensor and battery changes. The data from HOBOs can be are difficult to export into the Climate Notebook. At this institution there is a dedicated computer for all the environmental software and records to eliminate potential problems caused by multiple and different software systems and multiple peoples having access to the system. Those problems include lost data, slowness, and misplaced files. They have found that HOBOS to be less accurate and are less reliable over the long haul than the PEMs. If you need pin-point precision with your data, you may want a PEM. Accuracy of the ACR system is somewhere in between HOBOs and PEMs. Deciding which to purchase depends on what you need to do.

Resistance to monitoring and the need for it are common complaints among staff, especially since people can be too overly tweaked by small nuances like cycling or the converse, not knowing how to interpret the information (raw data or graph form). An additional problem is the perception that all of the data from the various types of monitoring equipment data needs to match EXACTLY, which is very unlikely.

Contributor 2

One participant could not recommend the SmartReader II. In this conservator's opinion, the SmartReader took most of a day to download and had batteries in them that require proprietary replacement by the company (i.e. costs upwards of $200–$300 to change the battery). Additionally, one could consider updating to a new model instead for a little more money when the batteries run low. However, be aware that once the batteries begin to run low, the humidity meter goes awry, thus disrupting the saved data.

Contributor 3

Although there are other considerations such as long term reliability, warranties, calibration, sensor replacement, flexibility and readability of downloaded data, the accuracy of moderately priced dataloggers are entirely adequate for describing daily fluctuations and seasonal change patterns, and are acceptable for a wide range of collection materials. Patterns of change are as important as refinement of the numbers. Of course, you will have to produce data that is credible, especially if it becomes a question of "who has the right numbers?" between facilities maintenance and conservation staff. Be prepared to bring your own testing equipment to confirm the conditions you are presenting. If cost is a concern, try the lowest priced instrument that can provide comparable performance to recommended brands (a HOBO, for example). Check the manufacturer's specifications—in particular, the "plus or minus" accuracy figures over which Relative Humidity and temperature range. Some units come with software; for others, it is an additional one-time cost. Make sure you are getting an 'apples to apples' comparison. See if you can work with the system on a trial basis before committing to the purchase. Although an added cost, use a good quality digital psychrometer to test readings of dataloggers, and to use to spot test the environment. Specialized scientific equipment suppliers may offer lower prices than general archival suppliers. Check out battery-powered, mechanical hygrothermographs, because they can provide the same useful data, are reliable, accurate if maintained properly, can be user-calibrated and the information is always immediately available to view. The downside is that you will have to buy charts and pens, which are getting pricey.

As far as convincing administrators of the importance of the collections' environment: after gathering the environmental records you hope to provide, present your concerns using a Risk Management approach. Prioritize your collections in terms of vulnerability and sensitivity to environmental change and extremes, and other potential hazards to your collections. Show examples of environmentally deteriorated collection objects and be well-informed of current information and research on the subject, and speak about with predicted rates of deterioration over time at varying relative humidity and temperature levels. Arrange visits for your superiors to institutions with superior environmental control as an incentive which could lead a better environment for your collections.

Contributor 4

My favorite data logger is the Preservation Environmental Monitor developed especially for use in Museums by the Image Permanence Institute at the Rochester Institute of Technology. Many different data loggers can gather T and RH data and present it in a graph. What sets the PEM above the others is the Climate Notebook software that was also developed by IPI. Climate Notebook performs numerous analysis functions, including comparing T and RH in different buildings or from different galleries. It generates several different reports that are not only easy to read, but easy to understand by allied museum professionals such as collections managers, climate control engineers, and directors. Climate Notebook will also accept data from other dataloggers such as Hobo.

We have 5 PEMs that we have moved around to 12 different buildings, gathering a year or two of data on each building and characterizing conditions to justify environmental upgrades. We use the reports as supporting data for NEH and IMLS grants. Once the grant project is complete, we submit Climate Notebook reports to show the improvement in the collections environment. IPI has recently updated the PEM and is embarking on an 18-month field test of the new and improved product. Each PEM runs for 5 years without a battery change and stores all the cumulative information. It can be downloaded to a data card and transferred into Climate Notebook on a PC. IPI provides excellent support for their product. PEMs are more expensive that Hobo's but I have found that they are certainly worth the cost.

Contributor 5

One contributor uses Hanwell radiologgers purchased through Greg Basso of Cascade Group. She states, "we have some ACR Smartreaders (dataloggers) that are approx. 10yrs. old that we use in some storage areas, crates and exhibition cases. Spaces can be monitored remotely from the desktop computer". Besides conservation staff, the registrars and the facilities engineers understand how the radiologgers work. A total of 2 or 3 of 60 staff members are charged with environmental monitoring. The space is a museum collection. In the galleries the loggers are placed in appropriate locations agreed upon by the designers and conservators. There is one logger per gallery and one per storage space. Monitors are also used in the conservation lab. The equipment has not been calibrated to date, as they have had the equipment for just 1½ yrs and haven't had to deal with calibration yet. The vendors claims the calibration is very stable and the loggers can be calibrated with the software. Purchasing this system was related to cost: they received an internal grant to acquire the system otherwise they could not have purchased it. The loggers are approx. $1000 ea. And the equipment to run them can be another $2500–5000 or more depending on the type of building/structure, size and distance of all the spaces that one wishes to monitor.

One of her positive points includes getting real-time readings and weekly and /or monthly charts for current or past months. The new system helped the institution revisit and establish guidelines for temperature and RH in the museum working with the facilities staff. They are currently monitoring a few storage areas, the conservation lab and about fourteen galleries. Soon, they will be increasing the number of gallery spaces with 10 more loggers. A unique application includes using a radio logger to monitor the interior of an exhibition case. The dataloggers are a little large to put in a case and require a special case design. The designers like the loggers better than hygrothermographs because they are smaller and less noticeable in the galleries.

On the negative side, the institution does not have sole control. They must rely on the vendor to make adjustments in the system when problems arise with access or the system is not working properly. One of the lessons learned includes "…as a government agency we cannot hold the FCC license needed for the system so the vendor holds the license. That could be a problem in the future if something should happen to the vendor."

Contributor 6

One of our contributors, Mark McCormick-Goodhart of Aardenburg Imaging & Archives, conducts image permanence research on modern digital printing technologies. One of his research projects includes a print monitoring program which tracks the aging process of prints in real-world (RW) settings via special picture frames that are embedded with two environmental data loggers and a light sensor. To read about this research, please see http://www.aardenburg-imaging.com/realworldprintmonitoring.html.

Contributor 7

This contributor used ACRs for long time, as they aged and were no longer viable, this same contributor sought and received an NEH grant to purchase all new PEM dataloggers and Climate Notebook software. The dataloggers were rolled into the grant proposal as part of exhibition. Private practice conservators who work with small collection might also try to roll environmental monitors and their corresponding software into grants they may write on behalf of those small institutions.

Contributor 8

For that matter, environmental monitoring equipment and software can also be included when developing Capital Campaign requests.

Contributor 9

The Rotronix datalogger system is also quite useful. It is easy to calibrate in-house using salt solutions. Once calibrated other dataloggers can be compared to the calibrated Rotronix datalogger to determine the accuracy of the other brand datalogger. Unlike dataloggers that must be recalibrated at the factory, those institutions with Rotronix dataloggers will never experience an extended downtime for recalibration.

Aircuity dataloggers measures temperature, relative humidity, and pollutants. However, they do not work well in cold storage environments. The Acuity datalogger's allowable pollutant levels are much higher than what would be considered acceptable in a museum environment. While this system may work well for office spaces, it is not suited for museum spaces.

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