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Comparison of Temperature and Relative Humidity Dataloggers for Museum Monitoring

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Knowledge is power. In museums, where detailed knowledge about environmental conditions is essential in preserving collections, knowing the environmental conditions of a particular storeroom or gallery is paramount. Each year there are multiple queries to preservation listserves such as NHCOLL-L, inquiring about the use of dataloggers for environmental monitoring. Most often these are general requests for information in preparation for purchasing units to use in a museum. The varied response to these postings can often be as overwhelming as the initial confusion caused by the number of different products on the market.

Conservators and Collection Managers often undertake environmental monitoring to obtain general trend information to develop an environmental profile of a particular space or to acquire data for specific projects. Dataloggers greatly expand the possibilities for environmental monitoring with specific project goals such as supporting the purchase of buffered exhibition or storage cases, or the installation or repair of heating, ventilation and air-conditioning (HVAC) systems. The ability of the building envelope to buffer the environment can also be assessed by comparing the indoor environment with exterior climate data. For these projects reliability, memory capacity and battery life remain important, but they may be outweighed by other needs such as size, display or alarm capability.

There are many dataloggers on the market that carry out basic monitoring functions. The accompanying table is by no means an exhaustive list. But, regardless of the options, planning ahead and having an outline of monitoring goals or requirements is necessary to choose a logger with the appropriate features at the right price.

What Are Dataloggers?

Dataloggers, in their most basic sense, are instruments that record a series of measurements, in this case temperature and relative humidity over time. They normally consist of a sensor that takes the readings, a memory chip for storing data and a microprocessor.

The loggers most commonly used by museums are small, stand alone battery-powered units that use specialized software when communicating with a personal computer to set parameters and alternatives but are outside the scope of this paper.

Datalogger Features

Determining a project's goals avoids wasting money on unnecessary features when working within a tight budget. Prices range widely from under \$100 to around \$1,000, not including the required computer software and cables. Probes, alarms and portable download units are additional costs. Unit price 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.

The following is a list of factors to consider when reviewing any logger's specifications. Please see the accompanying table for details.

Memory Capacity: Product literature describing memory capacity is often confusing. Most manufacturers list the number of readings the logger will take and store but, to actually compare memory capacity, it is essential to know if the manufacturer is listing the total number of readings or if the number must be divided by the number of operating channels. Many loggers require at least two channels: one to record temperature and a second for relative humidity. Some loggers allow extra channels to be enabled for additional features such as an external probe. The more channels that are activated, the fewer readings will be collected.

Battery Life: At a minimum, a logger should have battery life substantial enough to provide one full year of monitoring. The manufacturer should be consulted to check that the calculation for battery longevity is factored when the logger is working to capacity. For example, a logger with a one-year battery life may not last an entire year if the logger takes frequent readings during that period. It is also critical to check that, if the battery dies, the logger saves the data until a new battery is installed and the data downloaded.

Sensor Range and Accuracy: For monitoring the performance of environmental units such as HVAC systems, freezers and buffered cases, both the accuracy of the sensor and the operating range may be important. There is sometimes a difference between what is listed as the sensor's range and the logger's operating range. Read product data sheets carefully to know what the logger's real capacity is. Not all loggers are guaranteed to be accurate across the range of temperature and humidity that they record. 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. A few loggers allow the user to recalibrate, but most can be sent back to the manufacturer if they are not performing within their set parameters. The manufacturer should be consulted to determine if the listed accuracy of temperature readings listed is given for the entire range or for room temperature.

Size, Appearance and Construction: For projects designed to evaluate the environment in vitrines, buffered frame enclosures, storage cases and shipping crates the logger's size may be a determining factor. Casings are normally made of hard plastic and the colors and shapes vary. The casing of the logger should be durable and the sensor well protected. Only a few loggers on the market, such as the Hobo Pro, are weatherproof and suitable for outdoor use. The smallest loggers may be the most unobtrusive, but larger loggers generally can be screwed in place to fasten them securely, which is important when the units are installed in public spaces.

Display: Some projects may require a visible display of real-time data for spot checks. Some products now can show previous readings on the LCD allowing for a review of prior conditions. While the display is an extremely useful feature, it often greatly shortens the battery life.

Alarms: Some loggers have either visible or audible alarms to alert staff that set parameters have been exceeded. This feature is extremely useful in areas where a leak or other sudden change could cause severe damage. Alarms too may come at the cost of battery life.

Probes: Optional external probes may be available that are even less obtrusive and can be snaked into hard to reach spots, leaving the logger itself in a more accessible location for downloading.

Download Options: Data can be retrieved from the loggers either by bringing the unit back to a desktop computer or by connecting to a laptop in-situ. Some loggers also can be downloaded via a small handheld device such as a portable 'shuttle' or palm pilot. This is an alternative to the visible display for locations where frequent spot checks are necessary. For monitoring sealed environments, loggers are in development with infrared ports for wireless data transmission.

Download Speed: Download speed can become an important factor in choosing a logger if numerous units are to be placed and data is to be retrieved at frequent intervals. The speed of data transmission will vary depending on the memory size, type of interface cable and software as well as the speed of the personal computer.

Software Capabilities: All the hardware considerations discussed above are important, however, the logger's operating software is an area where differences between models become even more apparent. Some of the programs were more intuitive to use than others, but all were reasonably user friendly. All of the models were tested on a PC computer. There are far fewer software options for Apple/Macintosh users although some manufacturers do have an alternative Mac version available. All logger software should provide for easy launching, data retrieval and graph manipulation.

Most of the units allow the users to delay the onset of logging. Almost all the units allowed for a choice of stopping logging after a certain number of readings, stopping when full, or never stopping (i.e. wrap around). A highly useful function is the ability to back up or retrieve data from the logger without having to re-launch. This provides one long uninterrupted graph rather than many short ones. Most of the models allowed for this.

There are also several key graphing features: the ability to manipulate the X and Y axes to compare graphs, the ability to print the graph without having to export the data to a secondary program, and the ability to label the graph. The program should clearly display the time, date and year of the readings. It is often helpful to be able to view data in tabulated form and there may be occasions when it is useful to be able to export data to a spreadsheet program such as Excel. The ability to rename and organize the downloaded files is also convenient. Some programs only allow for names of eight characters while others allow up to twenty-four. The Climate Notebook Software from the Image Permanence Institute is the only program that supports importing data from a range of loggers. Additionally, it contains numerous other features that go beyond viewing and printing simple trends making it a powerful tool for analyzing and distributing environmental information.

Service and Technical Support: The reputation of the company and the quality of their service and technical support should also factor into the decision. There should be a product specialist at the firm (preferably more than one) who understands museum needs and can accurately answer any questions about their products. Several companies allow tests of their software via the Internet and many will send their logger for a 30-day free trial. All the products listed here come from reputable companies that were extremely helpful in lending their products and time.

Recommendations:

If datalogger files are not kept organized they can become useless. At the American Museum of Natural History several logs are kept to organize relevant information. An inventory log of all monitoring equipment lists the manufacturer, model and serial numbers and dates of calibration. A placement log records the launch settings by model and serial number to indicate how long it will record, the date it was placed, date retrieved, the location it was placed. This log also records the downloaded file name so the data can be found on the computer. The location of the loggers can be marked on an accompanying floor plan. Finally, an event log is maintained to record any unusual occurrences or general trends noted such as leaks, construction, HVAC malfunctions, steam or electricity outages or exterior climatic changes that may help explain anomalous logger readings. For even the most reliable loggers it is best to set a regular downloading schedule (e.g. once a month, every three months) to prevent loss of data.

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COMPANY MODEL WEBSITE	PRICE *for logger unit only as of 1/2002	SIZE *inches, millimeters, weight	OPERATING LIMITS *RH in non-condensing environment	ACCURACY *generally assessed at room temperature	MEMORY *# of temp and RH readings	POWER SOURCE/BATTERY LIFE *approximate life
ACR SmartReader 2 www.acrsystems.com	\$719	4.2x2.9x0.9 in 107x74x22 mm 5 oz / 110 g	-50°F to 160°F -45°C to 70°C 0-95% RH	+/-1°F +/-4% RH	16,384	Lithium battery 10 year life
Dickson FH121 www.dicksonweb.com	\$599	7.0x5.0x2.0 in 178x127x51 mm 1.2 lb / 544 g	0°F to 100°F 0°C to 100°C 0-95% RH	+/-1.8°F +/-2% RH	7,791	AC power 9 volt battery backup
Dickson TP120 www.dicksonweb.com	\$169	3.1x2.1x0.9 in 79x54x22 mm 1.8 oz / 49 g	-40°F to 176°F -40°C to 80°C 0-95% RH	+/-1.8°F +/-2% RH	16,256	Lithium battery 5 year life
Gemini Tinyview TV 1500 www.gemindataloggers.com	\$295	3.5x2.6x1.4 in 88x65x35 mm 3 oz / 85 g	-4°F to 158°F -20°C to 70°C 0-95% RH	+/-0.36°F +/-3% RH	14,800	Lithium battery 2 year life
Hanwell Humbug www.hanwellusa.com	\$649 with display	3.7x1.8x0.6 in 95x45x16 mm 3 oz / 85 g	-40°F to 176°F -40°C to 50°C 0-95% RH	+/-1°F +/-2% RH	8,000	Lithium battery 10 year life
Image Permanence Institute Preservation Environment Monitor www.rit.edu%7E661www1	\$650	6.5x4x1.75 in 165x102x45 mm 1.2 lb / 500 g	-67°F to 257°F -55°C to 125°C 5-95% RH	+/-0.1°F +/-2% RH	holds 1 year of 30-minute readings	Lithium batteries 5 year life
Langan XerIC Measurer www.langan.net	\$695	5.5x1.5x1.3 in 139x38x33 mm 6.5 oz / 184 g	0°F to 128°F -18°C to 53°C 0-100% RH	+/-0.5°F +/-0.5% RH	15,360	AA batteries 6 month life
Onset HOBO H8 RH/TEMP www.onsetcomp.com	\$85 \$95 w/ light or external channels	2.4x1.9x0.8 in 68x48x19 mm 1 oz / 29 g	-4°F to 158°F -20°C to 70°C 0-95% RH	+/-1.27°F +/-5% RH	3,971	Lithium battery 1 year life
Onset HOBO Pro RH/TEMP www.onsetcomp.com	\$159	4.7x3.3x0.9 in 120x86x25 mm 6.1oz / 173 g	-22°F to 122°F -30°C to 50°C 0-100% RH	+/-0.7°F +/-3% RH	32,645	Lithium battery 3 year life
Onset HOBO LCD Temp/RH www.onsetcomp.com	\$189	4x3.2x2 in 102x81x51 mm 3.7oz / 104 g	-4°F to 122°F -20°C to 50°C 15-80% RH	+/-1.26°F +/-3% RH	32,585	AAA batteries 1 year life
Trak-R TR-2000 www.trak-r-logger.com	\$498	5.3x3.3x1.2 in 133x83x29 mm 6oz / 170 g	0°F to 158°F -18°C to 70°C 15-90% RH	+/-2.7°F +/-4% RH	16,000	Lithium battery 1.5 year life
Veriteq Spectrum 2000 www.veriteq.com	\$425	2.8x2.1x0.7 in 71x53x18 mm 2.2oz / 62 g	-22°F to 158°F -30°C to 70°C 0-95% RH	+/-0.5°F +/-2% RH	10,900	Lithium battery 10 year life
Westronics Rustrak Scout RR-1040D www.westronics.com	\$1,095	4.6x7x2.3 in 117x177x58 mm 1.5lb / 680 g	30°F to 130°F 0°C to 50°C 0-100% RH	+/-3.6°F +/-0.5% RH	64,000	AC power Ni-Cad C cell battery 1 week life

COMPANY MODEL WEBSITE	DISPLAY	ALARM	PROBE	PORTABLE DOWNLOAD UNIT	DOWNLOAD SPEED *1 fast/ 3 slower	COMMENTS
ACR SmartReader 2 www.acrsystems.com	No	No	Yes	No	3	RH accuracy across entire range
Dickson FH121 www.dicksonweb.com	Yes	No	No	No	3	Can view data as graphed trend on LCD; humidity accuracy measured at 73°F; FH125 w/ external probe \$699
Dickson TP120 www.dicksonweb.com	No	No	No	No	3	Temperature accuracy range measured above 14°F
Gemini Tinyview TV 1500 www.gemindataloggers.com	Yes	Yes	No	No	3	Change of battery after 2 years recommended
Hanwell Humbug www.hanwellusa.com	Yes	Yes	Yes	No	1	\$549 w/o display
Image Permanence Institute Preservation Environment Monitor www.rit.edu%7E661www1	Yes	No	No	Yes	1	Downloaded using SRAM PC memory card; LCD can display previous 90 days of readings; Climate Notebook Software can view data imported from other loggers
Langan XerIC Measurer www.langan.net	Yes	No	Yes	No	2	Will record RH in condensing environment; battery life 2 years if display is not in constant activated use
Onset HOBO H8 RH/TEMP www.onsetcomp.com	No	No	No	Yes	2	+/- 5% RH accuracy not guaranteed <25% RH; similar related models also collect light and additional sensor data
Onset HOBO Pro RH/TEMP www.onsetcomp.com	No	No	Yes	Yes	2	Records RH in condensing environment; probe for temperature only
Onset HOBO LCD Temp/RH www.onsetcomp.com	Yes	Yes	Yes	Yes	2	LCD displays memory left and battery level; optional audible alarm in addition to visual alarm
Trak-R TR-2000 www.trak-r-logger.com	Yes	Yes	Yes	No	1	Temperature accuracy 1°F between 40-90°F; visual alarm with option for remote alarm and autodialer
Veriteq Spectrum 2000 www.veriteq.com	No	No	Yes	No	1	Distributed by Dickson as the D200
Westronics Rustrak Scout RR-1040D www.westronics.com	Yes	No	Yes	Yes	2	

References and Sources:

Daly, Gregg M., and Hugh J. Flye, 2000. "Dataloggers Deliver" In: *Engineered Systems* 17:8, pp.84-89
National Park Service. 1993. *Conserve-O-Gram* 3:3

ACR SmartReader 2 - Greg Basso, Cascade Group Inc., personal communication and June Wheeler, Herzog /Wheeler & Associates, personal communication. Order from the Cascade Group, 68 West Main Street, Oyster Bay, NY 11771. Tel: (516) 624-9362, Fax: (516) 624-9363 or Authorized Representative Herzog/Wheeler & Associates, 2183 Summit Avenue St. Paul, MN 55105. Tel (651) 647-1035, Fax: (651) 647-1041.

Dickson FH121 and TP120 - Chris Sorensen, Dickson, personal communication. Order directly from Dickson, 930 S. Westwood Avenue, Addison, IL 60101-4917. Tel: 1-800-323-2448 or (630) 543-3747, Fax: 1-800-676-0498 or (630) 543-0498.

Gemini Tinyview TV1500 - Steven Weintraub, Craig Oleszewski, and Richard McCoy, Art Preservation Services, personal communication. Order from Art Preservation Services 315 East 89th Street, New York, NY 10128. Tel: (212) 722-6300, Fax: (212) 427-6726.

Hanwell Humbug - Greg Basso, Cascade Group Inc., personal communication. Order from Cascade Group, 68 West Main Street, Oyster Bay, NY 11771. Tel: (516) 624-9362, Fax: (516) 624-9363.

Langan XerIC Measurer - Lee Langan, Langan Products Inc. personal communication
To purchase contact Lee Langan directly at lee@langan.net.

Onset Hobo H8, Hobo Pro Series and Hobo LCD - Scott Ellis and Hugh Flye, Onset Computer Corporation, personal communication. Order from Onset Computer Corporation. Tel: 1-800-564-4377 or (508) 759-9500, Fax: (508) 759-9100.

Preservation Environment Monitor - Jim Reilly and Ed Zinn, personal communication. Order from Image Permanence Institute, Rochester Institute of Technology, 70 Lomb Memorial Drive, Rochester, NY 14623-5604. Tel: (716) 475-5199, Fax: (716) 475-7230.

Trak-R TL-2000 - Gene Giffords, Trak-R Logger, personal communication. Order from Trak-R Logger, GS Energy Corporation, 61 Brightside Avenue, Central Islip, NY 11722. Tel: (516) 582-1808 or (800) 865-6443, Fax: (516) 582-1895.

Veriteq Spectrum 2000 - Frits de Geest, Veriteq Instruments Inc., personal communication and Chris Sorensen, Dickson, personal communication. Order from Dickson where it is sold as the Dickson D200. Tel: 1-800-323-2448, Fax: 1-800-676-0498. Alternatively contact Veriteq's U.S. Reseller – RJM Sales, Scotch Plains, NJ. Tel: (908) 322-7880.

Westronics Rustrak Scout - Lou Barker, Westronics Inc., personal communication. To order contact Westronics at 22001 North Park Drive, Suite 100, Kingwood, TX 77339-3804. Tel: (281) 348-1800 Fax: (281) 348-1288 or check their website for the appropriate sales representative.