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Automating and Monitoring Biotech Storage Environments

Genetic Therapy, Inc. uses FieldPoint and Lookout to develop monitoring applications

Gregory C. Cala, PhD and David S. Reed

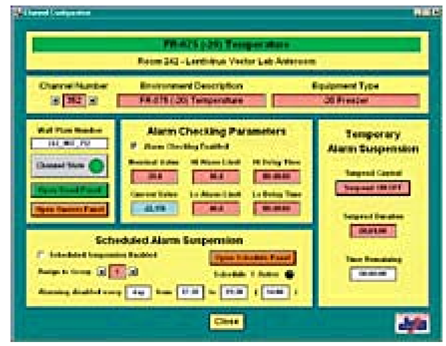

***Figure 1:** Panel for configuring the parameters of an individual data acquisition channel*

Genetic Therapy, Inc. (GTI) recently constructed a new building in Gaithersburg, Maryland for biotech research. The new facility needed a system to provide unattended monitoring and data logging of microenvironments used to culture and preserve experiments. Protecting this valuable research meant continuously evaluating a variety of alarms.

The automated system needed to monitor and log equipment temperatures for up to 500 sensors located throughout a state-of-the-art biotechnology research facility. The system had to operate unattended 24 hours a day, and had to alert on-call technicians via pager of any out-of-range alarm events or equipment failures.

To meet these needs, Data Science Automation (DSA) built a system for GTI that acquires and conditions the sensor data remotely using National Instruments FieldPoint nodes located throughout the facility. The system then communicates the data to a central PC via RS-485, checks limits, and logs and trends the data with National Instruments Lookout 4.0.

System Configuration

Initial requirements for facilities monitoring called for equipping 383 devices with sensors for measuring temperatures, gas concentrations, and alarm relays. The system needed to monitor devices such as liquid nitrogen (LN) dewars, freezers, refrigerators, and cell culture incubators. The devices are located throughout 72 laboratories, storage areas, and hallways on two floors of the building, and at a separate site nearby called the G&A building. The widespread physical distribution of the equipment made it necessary to divide the collection of sensors into nine groups or "nodes," each surrounding a remote data acquisition unit.

***Figure 2a:** Panel to configure the groups of scheduled alarm suspension*

DSA selected National Instruments FieldPoint distributed I/O for the remote data acquisition units, supporting the measurement of 362 individual 3-wire RTD temperature probes (measuring -80C to ambient), 11 voltages produced by incubator CO concentration monitors (nominally 50 mV), and 21 digital relay closures provided by LN tank monitoring units. These channels were acquired using 46

FP-RTD-122 units, 2 FP-AI-110 units, and 2 FP-DI-301 units with external 24 VDC supplies to provide electrical continuity.

The acquired data is communicated to a central control PC via nine FP-1001 RS-485 network modules on four full-duplex shielded cables, one of which was dedicated to the G&A building. DSA mounted the nine nodes, each consisting of a network module and five or six data acquisition modules, above the drop ceiling in the hallways for easy maintenance access. PS-3 float chargers power the nodes in parallel with 12-Volt 7-Ahr UPS batteries to ensure continuous operation during power outages.

During building construction, a total of 496 4-wire cables (including 102 spares) were pulled through the ceilings from the data acquisition nodes to the locations of the monitored devices. These cables are fed down the walls to wall plates containing from one to six DB-9S jacks, each with a wall plate number denoting room, node, and a serial number. Within the rooms, an additional three to four meters of cable connect the corresponding DB-9P plugs to one of the three types of sensors located within the equipment being monitored. Since each wall jack is connected to a specific FieldPoint input module, each sensor type uses a different set of wires within the cables. DSA chose configurations to ensure that a complete circuit formed only when the proper sensor was connected.

System Software

DSA chose National Instruments Lookout for developing the Facility Monitoring System (FMS) software, in part because of its flexible, object-oriented nature. Lookout promised fast development, easy modification, built-in data logging and trending, and transparent network connectivity, which supported client-server architecture.

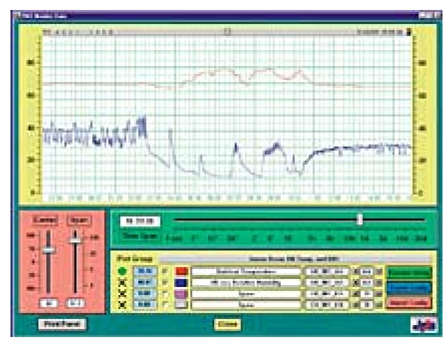

Figure 2b: *Channel Configuration Panel*

Each of the 500 sensor channels defined in the software needed a high and low alarm limit, both with associated delay periods to provide hysteresis and prevent nuisance alarms. As seen in Figure 1, a single panel provided the interface to set these parameters, along with two forms of alarm suspending: temporary by timer and periodic by schedule. During periods of alarm suspension, selected channel data are not compared to alarm thresholds so that the alarm indication and notification functions are disabled. Temporary suspension by timer, used while equipment is off-line for servicing, ensures that alarming will be automatically re-enabled upon expiration of the specified time duration. Scheduled suspension prevents false alarms during periodic scheduled events such as freezer defrost cycles. Figure 2a shows the scheduled suspension configuration panel that can be accessed from any of the channel configuration panels. The parameters used to schedule alarm suspensions include frequency, start time, and duration. Schedule parameters cannot be modified on the channel configuration panel-only viewed. With channel grouping, the same alarm suspension schedule parameters can be easily applied to multiple channels. To reduce nuisance alarms during normal operation, alarm delays compensate for normal disturbances that exceed alarm limits, such as when researchers open doors or when the freezer is in a defrost cycle. The alarm only sounds when conditions beyond alarm limits are sustained over a specified period.

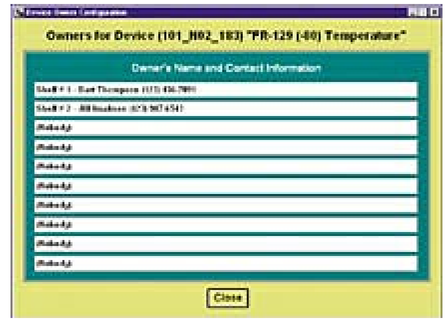

Figure 2c: Panel for entry and review of device owner information

The channel configuration panel also provides access to a real-time, historical trend plot and another panel with device ownership information. An icon to the left summarizes the channel state using a combination of color and shape to indicate if the channel is nominal, above or below limits, in alarm above or below limits, suspended, or if alarm checking is disabled. The historical trend panel provides a flexible and innovative graphical means by which to review up to four data channels at a time. Both vertical axis (measured value) and horizontal axis (time) spans can be easily adjusted over ranges sufficiently large to view any reasonable set of data. With the insight gained from the review of data from channels both in and out of alarm state, the user can set alarm suspension and delay parameters more intelligently. This results in the near elimination of all nuisance alarms and the prevention of oversight of subtle events that required indication and notification. With the device owner panel, users can track the primary stakeholder for notification and data management purposes.

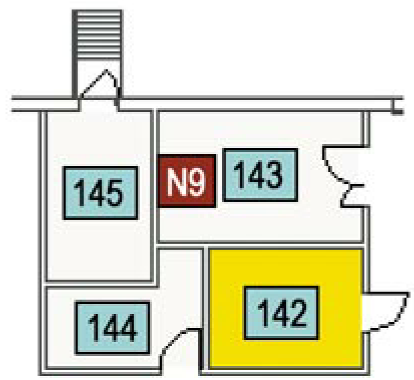

Figure 3: Section of floor plan showing room 142 with a microenvironment out of limits

Presenting and navigating through such a large number of configurable points called for an innovative method of managing the user interface. The FMS client process provides nearly all the operator interface to the system, mainly in the form of a hierarchy of floor plans. Rooms in the facility containing any microenvironments in an alarm state will flash red on the main panel. Otherwise, as depicted in Figure 3, rooms are displayed in a steady yellow if an environment is out of limits (but not long enough to qualify as an alarm) and in white if everything within is nominal.

When an operator clicks the mouse anywhere on a room image, a panel similar to Figure 4 appears, providing additional detail. An icon showing the channel serial number, the device name, its state icon, and its current value represents monitored devices. These icons flash red or yellow as appropriate to draw attention. Clicking on a device icon opens the channel configuration panel shown in Figure 1.

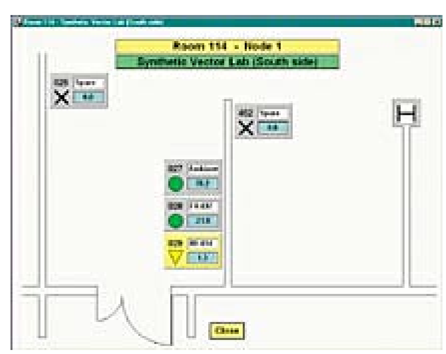

Figure 4: Room 114 floor plan showing refrigerator #14 below limits

Connecting the acquired channels to a single data table object makes logging and alarm control for all 500 channels easy. Custom alarm objects make the sophisticated alarming scheme possible. This alarming scheme evaluates and notifies technicians of only legitimate alarm states, and uses a numeric code to specify the device type, current value, room number, and serial number of the alarm event. DSA dedicated a significant portion of the entire effort to the design of the software architecture, which allowed a streamlined development phase and incorporated flexibility and scalability features to accommodate future functional enhancements and channel count growth.

In all, the features of Lookout and FieldPoint made the difference in successfully creating a flexible system that fit within a tight schedule and budget. Whenever a system requires the integration of hardware and software, the attention to detail that is paid by the product manufacturer provides significant return on investment. In this case, the fact that both the Fieldpoint hardware and the Lookout software were products of the same manufacturer streamlined development. Subsequent to the system going live and after sufficient operational experience and insight had been gained regarding the system functionality, the end users solicited feedback to identify opportunities to improve potential future installations of similar systems.

Because the FMS supports activities regulated by the Food and Drug Administration, the system is being validated. The validation includes a number of activities that are completed to ensure that the FMS development effort is appropriately documented and that the system is installed and operates correctly.

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