We rely on control systems to monitor and manage our building systems. For the most part it’s been assumed that once the control system is installed and configured it will work for years with little attention and minimal maintenance. Some systems may be trouble-free, but the majority of them will need regular attention and maintenance. Over time hardware will fail, software parameters and versions change and slowly the control system will “drift” from its original configuration and performance.

The role of control systems is somewhat undervalued. When you examine the most complex system in most buildings, the HVAC infrastructure, you find that it’s the HVAC control system, not the HVAC equipment, which produces the most operational issues and is the leading cause of inefficient energy use. Lawrence Berkley National Laboratories examined 60 buildings and found the highest frequency of common problems with HVAC was in the control system. Texas A&M research determined that of the operational and maintenance measures that could produce significant energy savings, 77% of the savings were from correcting control problems.

Maintaining a high performing control system involves regular maintenance, software and data management and organizational policies. The issues that can cause problems with a building control system are the same challenges all of us have had at one time or another with our computer or smartphone: problems related to software, hardware, communications networking and “user” mistakes. What follows is an overview of some of the typical control system issues and recommendations as to how to keep it performing at a high level.
Software Issues

Software is probably the number one issue with control systems. Given that control systems are networks monitoring and managing data points and running control sequence programs, issues with software and the management of data is no big surprise. Problems can crop up with the initial configuration of the data points in a new or replacement BMS system. In existing buildings you may find multiple naming conventions, a lack of as-built control drawings and overall poor data management, thus making it difficult and time consuming to obtain accurate information on point configuration. Even if you get accurate information on the data points there may be human errors in configuring the points in the software.

Beyond the configuration of individual points is the organization of the control strategy software where both the control logic and appropriate parameters must be identified. If the control logic between different HVAC equipment is not sound, or parameters for set points or ranges for other data variables are not suitable, or if the space use has changed, you have a control system that is providing sub-optimal performance for the underlying building system.

The BMS that manages and monitors controllers, data points, control sequences, etc. can also be a software issue. Many of the problems are related to the BMS really being an IT device; it has databases, operating systems, software applications, requirements for security and a need for IT support. With no underlying support from IT or a lack of IT expertise within Facility Management, you are bound to have software problems come up. In addition, a typical BMS system also has problems of “omission”. The BMS may not have graphics, analytic software or any application tools or displays to support technicians and engineers in quickly identifying problems and their likely remedy.
Communications Issues

Assuming that the software and hardware of a control system is properly working, network communication problems will usually involve cabling faults, improper cabling, excessive network traffic or the interface into IT network equipment. Cabling can get damaged and network connections can become loose resulting in a loss of signal across a communications span. If you’re using wireless technology you can possibly lose contact if you’re using an unlicensed frequency and other equipment using the same frequency is introduced into the space, causing interference.

The interface of a control system into the client’s IT network is another potential source of communication issues. It involves not only cabling into an IT network switch, but possibly additional equipment such as a gateway that may be need to translate the control systems protocol and data format into an acceptable format and protocol for the IT network.

With field controllers where the controller uses an analog signal to communicate with the field device such as temperature sensor the issue is calibration. A typical sensor may signal their output via a range over a DC current (4mA to 20mA is a common example, identifying zero level and maximum level of the output of the device). These analog communication links need to be calibrated, configured and validated to ensure the controller is getting accurate data.

Hardware Issues

At some point hardware devices fail, so every piece of hardware in a control system is a potential point of failure and possible hitch. At the lowest control system level we have devices that provide or facilitate communication of the monitoring data to the system, with the data usually being a measurement or state of a device. These are the typical sensors, relays and transducers. In addition to complete failure of a device such as a sensor, you can have an operating sensor
that’s just inaccurate. Sensors need to be recalibrated on a regular basis although many organizations never think to do so. The issue here being the control system may be receiving and acting on inaccurate or poor quality data.

At this same control system level are devices that the control system is managing and controlling. These are devices such as valve or damper operators and variable speed drives. Failure of the device, such as a leaking control valve, really negates the control request and overall control strategy of the building system.

The controller themselves may fail. This is typically related to controller’s circuit board, either the components on the circuit board or the board’s ability to bond different parts of the board.

**Operator Issues**

Operator issues are the human aspect of control systems. A typical example would be an engineer or a technician overriding a control parameter such as a set point, but not documenting the change. The override affects the control system, as well as other engineers or technicians that may be working on that portion of the system but not informed of the change. This human aspect of the control systems plays a part at the larger organizational level of a Facility Management department, where the operation that doesn’t emphasize preventative maintenance training for its staff or maintenance of the control systems.

**Steps to Take**

1. Inventory and document your control systems. Identify the location of all equipment and the version of the components and software.
2. Recalibrate your sensors as well as the analog signals to the field controllers.
3. Gather and manage data related to the control systems such as as-built control drawings and points a list. Don’t wait for an emergency and then have to scramble to find everything.
4. Audit and evaluate the existing controllers for parts availability, service, and overall capability.
5. Develop a step-by-step methodology for troubleshooting. For example, you may start with the information from the BMS, check the controllers and any IT network involved, which should help in localizing the problem. After that you may need some instrumentation to check cables, communications signals, and voltage or current between a field controller and a sensor or actuator.
6. Assess the needs of the building owner and operators. If you are dealing with a portfolio of buildings, get a BMS system that can provide an enterprise-wide solution rather than managing buildings individually.
7. Identify the software applications required. At a minimum you’ll need energy management and an analytic application, such as fault detection and diagnostics.
8. Evaluate whether an upgrade is justified. Take into account maintenance cost on the older control system and the energy savings and potential utility rebates and incentives on the new control system.

**Bottom Line:** The performance level of a building is directly related to the performance level of its control systems. You cannot manage a high performance building without high performing control systems.

For more information, write us at info@smart-buildings.com

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