The control for the Hijend hotel was originally designed as a full DDC system. But it, along with the central plant was heavily value engineered during the bidding cycle due to budget issues. During the control system value engineering process:

a. Zone controls were reverted from DDC to pneumatic, including the control of the guest room fan coil units.

b. Proof of operation points were eliminated unless they were required for some portion of the control logic and the function could not be provided in any other way.

c. Sensor were procured on a best first cost basis and specified as the manufacture's standard product, meaning generally less accuracy than originally designed

d. Trending requirements were reduced to the manufacture's standard. As a result, trend samples are universally set at 30 minutes currently. It is possible to increase the sampling rate to a maximum of once every 5 minutes on a point by point basis. But the network architecture will not support the traffic rates associated with sampling all points at this frequency. It is possible to use this frequency on a system by system basis.

e. Flow meters and flow measuring stations were eliminated. But, since the venturi style measuring element that was to be used by the control system was specified in the mechanical piping section, the sensing elements were installed because the VE team missed eliminating them. But nobody realizes they are there.

f. BACnet or other network type integrations to packaged control systems like the chillers were eliminated.

g. Poly tubing with barbed fittings was used for the pneumatic system other than where exposed, where copper was provided.

h. Only points deemed necessary for control were provided. For instance if an AHU could be controlled based solely on discharge temperature, then no sensors were provided at intermediate points in the system, like in the mixed air plenum or after a preheat/heating coil.

Since construction a number of changes and improvements have been undertaken during renovation cycles or at the initiative of the operating team as they attempted to solve operational problems like nuisance freezestat trips on start up (no mixed air low limit cycle) and learned about the value of having accurate data in terms of operating their facility efficiently. Some of the improvements are being accomplished in-house using a upgrade by repair strategy

- In a recent guest room renovation, the original pneumatic thermostats were replaced with the hotel chain's new standard wireless networked thermostat. However, the pneumatic control valves on the fan coils were retained because it was cheaper to interface them with the electric thermostat using two EP switches than it was to replace the valves. There have been a number of issues that have come up as a result.

    a. Guest complaints due to the "click" that occurs when the EP switches are triggered.

    b. An improper repair that was made by an engineering tech. They had a work order to troubleshoot a guest room where the system would not cool. In their trouble shooting effort, they had been disconnecting wiring and tubing from the EP switches and finally identified that the problem was that the EP switch that opened the chilled water valve had failed. But when they went to reconnect everything, they realized they did not know which wire and which tube was associated with the thermostat heating output, cooling output, heating valve and cooling valve.

    So they made an educated guess, connected things up and tested the system by triggering a call for heat and determining if heat was delivered and vice versa for a call for cooling. If they got the wrong result, they tried changing the connections until, at last, they had a solution that, when they triggered a call for heat, started the fan coil unit fan and delivered hot air and on a call for cooling, started the fan coil unit fan and delivered cold air.

Then to avoid making the same mistake in the future, they carefully documented their connections in a sketch that they shared with their team mates so they would no how to rewire and pipe things when they needed to make a similar repair, which was happening more frequently due to the age of the EP valves.

Unfortunately, their solution worked by keeping both valves open when there was not call for heating or cooling and then starting the fan and closing the hot water valve when there was a call for cooling and starting the fan and closing the chilled water valve when there was a call for heating. As a result, for the units were the repair had been implemented, there was a small but steady simultaneous heating and cooling load introduce by conduction from the chilled water coil to the hot water coil since they were bolted together in the unit. And in rooms where the guest set the fan to continuous operation temperature control was somewhat erratic and the loads where high because of the interaction of the concurrently active chilled and hot water coils when the thermostat was satisfied and the fan was running.

c. A poor insulation detail for the original fan coil unit chilled water valves results in significant corrosion of the valve bonnet. As a result, when the corrosion is severe enough, when full main air pressure is applied to close the valve, the bonnet fails and the guest room floods. The resulting water damage to the room as well as adjacent rooms (both next door and below) is expensive, especially when the funds paid to compensate the guests are taken into account.

d. The valve plugs on the original hot water valves were rubber, which over the years has cracked and eroded away, resulting in significant leak-by when the valve is closed. In addition to compromising the cooling capability of the fan coil unit, the leak-by imposes a simultaneous heating and cooling load on the central plant.

e. The pneumatic distribution system is extensive and leaky. As a result, portions of the system at remote locations have significantly lower main air pressure available to them. In turn, it is not uncommon for there to be insufficient air pressure available to fully actuate the fan coil unit chilled and hot water valves. In other words, if a Normally Open hot water valve had a 3-10 psi spring in it and the air pressure available is 8 psig due to the pressure drop in the mains created by the flow caused by the leaks, then the hot water valve will never close even though the EP switch is apply main air pressure. As a result, cooling is impacted and an unintentional simultaneous heating and cooling load is created.

The operating team is aware of issues "a", "c", and "e" but not the other issues. And they do not fully appreciate the energy cost implications of the issues. But as a result of what they do know, they are converting fan coils to electric valves when issue "c" occurs or if they have a guest room out of service for some reason and have enough time to make the change. At this point, about 5% of the rooms have been upgraded. They have put in for a CapEx project to convert to electric valves on a floor by floor basis but it keeps getting put off because of the cost and lost revenue associated with taking guest rooms out of service.

- After attending the hotel chain's AEP (Advanced Engineering Training) program and recognizing the power of trending and diagnostic points, the chief has started a project where they are upgrading the input sensors to the control system and, if the capacity exists in the controllers, adding sensors for diagnostics. So far, they have completed the upgrade effort in the central plant and for several of the air handling systems, including the Ball Room AHU and the Corridor Make Up Air systems. The new temperature sensors are indicating sensors but there are still issues with relative calibration and in some cases, single point sensors have been installed when averaging sensors would be a better or necessary solution.

  Some of this work is being accomplished in house as time and budget permits. But if a system is overhauled or renovated, the team endeavors to include the sensor upgrades in the project if possible. But they have yet to realize they need to specify all of the features they want, which is why they have ended up with the single point sensors in mixed air plenums; they asked for an indicating sensor with the accuracy they felt they needed but did not require averaging sensors. Hotel policy required them to take the low bid,

so even though their favored vendor knew that averaging sensors would be desirable in some locations, because they included them in their bid, they came in high.

- A number of the systems in the facility were provided with Variable Speed Drives (VSDs) in the form of a VFD (Variable Frequency Drive) under the auspices of a utility incentive program targeting improving energy efficiency. Unfortunately, the program literally incented the Owner to add a VFD to their system but did not provide for controlling it. The program simply removed the existing across the line starter and replaced it with a VFD and connected it to the existing control system points that were serving the original starter. As a result. several constant volume air handling systems in the facility have a VFD that does nothing (but waste energy due to drive losses). The drives were set to manual, full speed and any points that existed prior the installation (start/stop and safeties for instance) were wired to the drive.