EOS

ENERGY OPTIMIZATION SYSTEM™

- Internet of Things
- Big Data
- Cloud Computing

www.shiftenergy.com

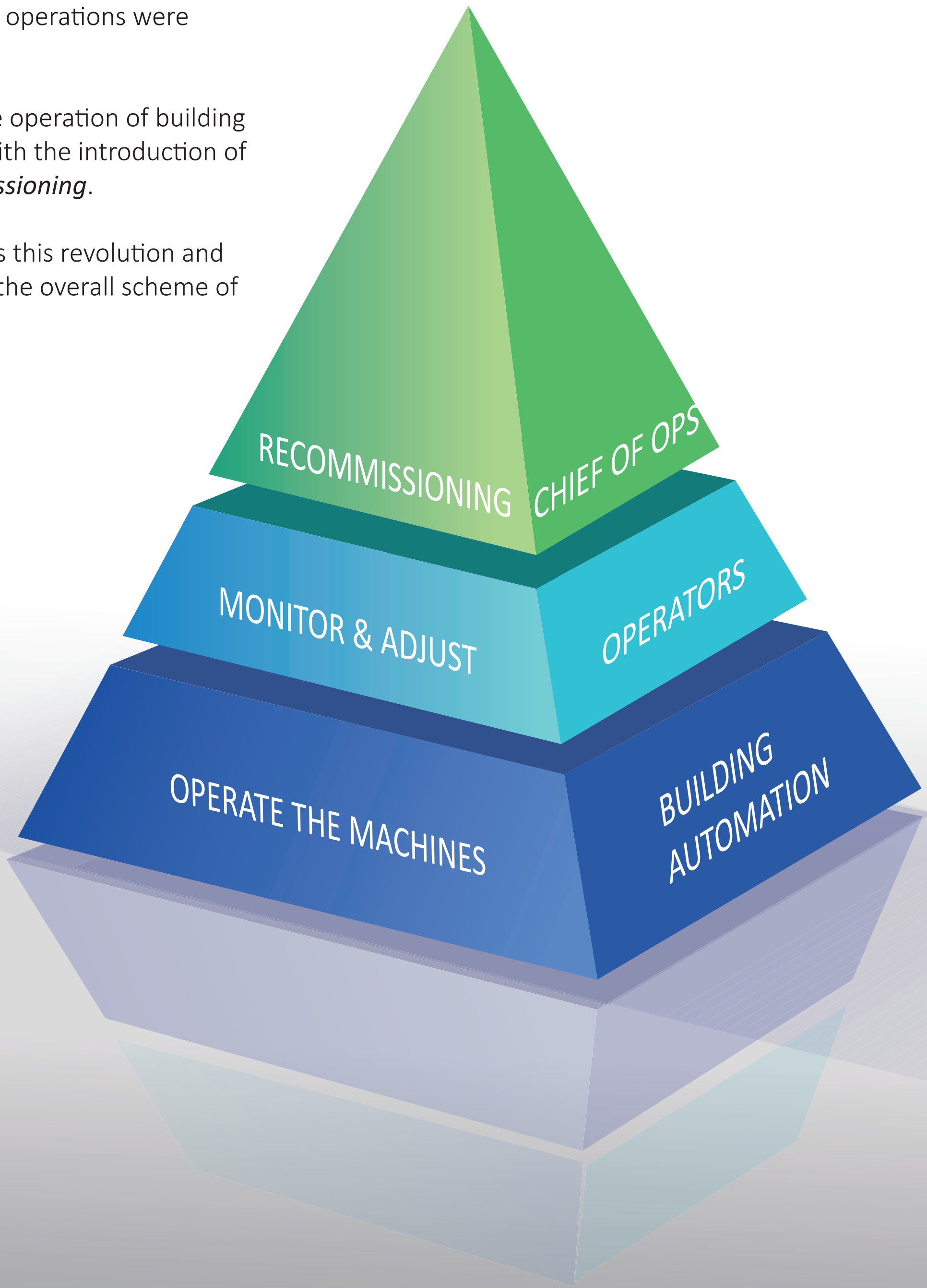
SHIFT ENERGY
A MARINER COMPANY

A Revolution in the Operation of Buildings

The modern electronic thermostat was invented in 1883 by Warren Johnson. It changed the way operators and occupants engaged with their HVAC (Heating, Ventilation, Air condition, Cooling) system. Building operations were revolutionized.

Another revolution in the operation of building systems is taking place with the introduction of *Intelligent Live Recommissioning*.

This white paper explores this revolution and identifies where it fits in the overall scheme of building operations.



Bottom Layer

Operate the Machines

The bottom layer of the functional layers of building operation is the Building Automation Systems (BAS). This layer provides basic control functions, such as:

- Bang-bang control
- PID control
- Timer
- Sequencer

This layer operates the machines in the building 24/7 to a set of targets and setpoints defined during commissioning. For example, a daily occupancy schedule is stored as time values that are passed to timers that trigger the appropriate start-up and shut-down each day. For another example, PID loops take a setpoint for a process and converge on that value by adjusting the process inputs. In most building control PID loops, they operate as a “single input single output” controller. The great benefit of BAS is that it automates thousands of updates a day to maintain facility operations at setpoint values. Imagine a person sitting at a screen trying to achieve the same thing manually- it’s impossible.

Bang-Bang Controller

Also known as a hysteresis controller, Bang-bang Controller is a feedback controller that switches abruptly between two states.

PID Controller

A proportional-integral-derivative (PID) controller calculates an output based on the error between the desired process setpoint and the actual process value.

Monitor & Adjust

The middle layer of building operation builds upon the first by making adjustments to the setpoints and time schedules in the BAS. This work is shared between the BAS and the operators.

A number of factors drive these adjustments:

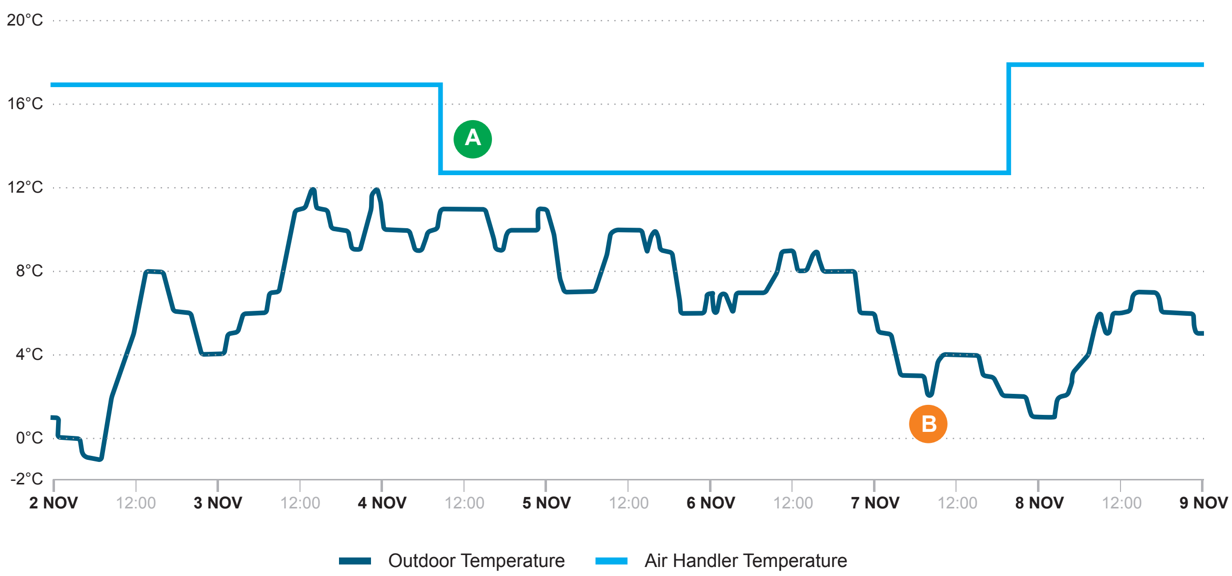
- Changes in environment, weather
- Changes in use of the spaces: schedule, nature of use or mode
- Occupant complaints
- Equipment degradation or failure
- Defined operations procedures
- Seasonal changes
- Other interrelated changes in the BAS

A modern BAS may include a feature here called an outdoor reset, which adjusts for temperature by tracking the setpoint up and down with changes in outdoor air temperature. Properly done, outdoor resets can avoid situations like the one shown in the figure.

But often operators make changes in the configuration of this reset strategy because of the other factors mentioned above, or perhaps because the initial setup of the reset was not tested over the course of a year for situations like the hottest and coldest days.

There is another very important function that takes place at this layer. Operators translate the information about what is needed in individual spaces into parameters that the BAS can use. For example if a room is to be used from 8 AM to 5 PM, operators will translate that into 7 AM to 5 PM for the BAS, so that there is a sufficient start-up period to have the room at the desired conditions at 8 AM. In some cases it may be possible for the BAS to perform this “start-up offset” translation. In another example, if a space is going to hold 200 people instead of the usual 10, then operators will translate that into a supply air temperature setpoint of 12 °C, instead of the usual 15 °C, to account for the additional occupant heat and air cooling need.

Many other adjustments and optimizations are possible if there is sufficient time for operators to perform all of it, and if there is sufficient communication to identify these issues.



The above plot shows the discharge air temperature setpoint for an air handler, and the outdoor air temperature, over the course of a week. It shows how the operators made and adjustment on A the morning of 4-November, reducing the setpoint, and raising it again on B the afternoon of 7-November, to a value higher than the original temperature. This adjustment was made by the operators to compensate for the change in outdoor air temperature.

Recommissioning

Ideally this top layer in building operations would occur continuously, as recommended in many guides on Continuous Commissioning® (CC®)[1]. In practice, this may happen once every five years. While many facilities start out on a Continuous Commissioning path, only about 1 in 10 facilities can keep up with Continuous Commissioning over the longer term, based on an examination of 33 buildings[2].

The primary goals of this layer are:

- Analyze operations
- Identify opportunities for improvement
- Ensure that the company's goals are being adhered to
- Make corrections to the middle layer as necessary

The goals of the company may be something like:

1. Ensure comfort and safety
2. Protect the equipment assets and prolong their life
3. Reduce costs

In order to meet these goals, an organization must check that the building automation and the schedule and setpoint adjustments are meeting those goals. For example, it would be ideal if the Chief of Operations could look at a number of reports once a week that summarized any issues:

- Any comfort requirements not met
- A compliance report against any standards or codes for the building
- Any equipment getting cycled faster than its short cycle limits
- A summary of the run hours for all equipment
- A summary of the run-levels (throttle) for all equipment
- A summary of any equipment degradations or defects that were detected
- A list of all BAS points put into manual override
- A summary of energy performance compared to a normalized baseline at a building and equipment level

Based on information suggested here, corrective actions could be taken to ensure the best possible building operation. Without this information, issues may persist for an indefinite period, until a recommissioning takes place, or until something fails.

> "Only about 1 in 10 facilities can keep up with Continuous Commissioning over the longer term, based on an examination of 33 buildings Project Requirements"[2].

[1] *Continuous Commissioning® (CC®) is the registered trademarks of Energy Systems Laboratory (ESL).*

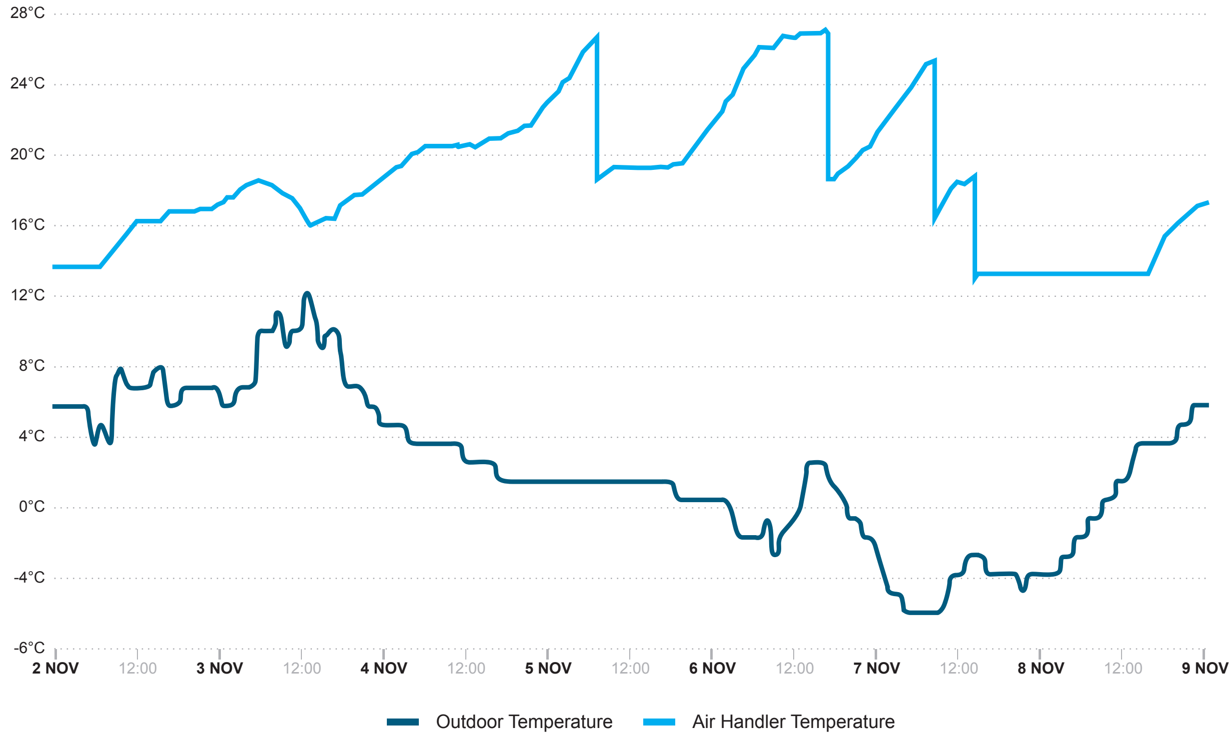
[2] *EneryMentor™ Research Data by SHIFT Energy 2010-2012.*

Intelligent Live Recommissioning (ILR)

Intelligent Live Recommissioning is revolutionizing building operations by automating the functions in the middle "Adjustments" and top "Recommissioning" layers. This is done by adding a software layer on top of the BAS, where the software both reads and writes from/to the BAS. This software layer can overcome many of the limitations that do not allow us to perform these functions as often as we would like, or over as much of the building as we would like. ILR can also take on more complexity that would befit either a human operator or a BAS.

It is possible to make adjustments on a unit based on-analysis of the needs of units connected downstream of it using analytics more complex than the best "sequence of operations" in a BAS. Whereas a BAS may often reduce a control problem to a single input, single output equation, ILR can use a control scheme based on data from hundreds of downstream units connected to the process. This exceeds the performance and efficiency of typical strategies such as outdoor resets, or static pressure setpoints.

The adjustments of ILR can be made every minute, day and night, making the system dynamic.



This plot shows a situation, similar to the one we discussed in the Middle Layer; where an air handler is adjusted throughout the week. In the former example, operators only made 2 adjustments which were perhaps not precisely timed to the weather. In this example, the automated adjustments are continuous throughout the week. And the adjustments do not track to weather directly. In fact they actually track to the needs of the spaces connected to this air handler, which at times aligns with the weather, and at other times does not.

Another feature of this example is that the ILR process at times detected that comfort issues were pending, and made corrections to the setpoint to prevent the comfort issues from materializing. This is superior to the traditional reporting of the incidents after they occur. When the supervision and adjustments are automated, the comfort incidents are prevented before they occur.

Reporting:

With the IT technology of today, rich, interactive reporting is available from a software layer on top of the BAS. Users can drill down into the underlying details of the summaries in the reports, and plot them. Today's IT can also maintain a deep history of the data from the building for later analysis, comparison, and reporting.

And the information can be accessible from outside the building, without any changes to firewall rules, or networking in the building.

Change:

Intelligent Live Recommissioning is revolutionizing building control, changing the role of the operator, and changing the way that occupants engage with their building environment, just like the first electrical thermostat revolutionized building control.

For example, consider the process of translating information about how a space is going to be used into how the equipment should be run. It used to be an all-people process. People defined the intended use of the spaces. Operators then translated that into information for the BAS. And corrections were again a people based complaints process. The automation of ILR allows the people to focus on the first part: how are the spaces going to be used and when. ILR can then translate that information into the requirements for the spaces. And the software can monitor conditions and make adjustments should any comfort issues begin to appear – before a complaint occurs. This lets the people focus on what they want to do with the spaces, lets operators focus on how their equipment is performing and reduces time spent responding to complaints.

Operators can review reports about how the building is doing, and begin to pro-actively manage the issues, instead of reacting when something breaks. Addressing issues in the equipment in the building sooner extends the life of the equipment, reduces the cost to operate it, and makes eventual maintenance work less costly.

With such holistic management, the building can also operate more efficiently. No more does and air handler have to cool air to 13 °C if every unit downstream is heating the air back up to 16 °C or more. The cooling at the air handler can be reduced a little to minimize downstream reheat while meeting all of the space requirements. No more does a pump have to run at 100% all of the time when the needed pressures can be met at 40% throttle most of the time. Many services in a building may be throttled back at night when the actual needs in the building are less – so that the building begins to actually "sleep" in a lower power state at night.

Conclusion

Software has changed the way our world operates. Things that were impossible before have become possible. This revolution can now be applied to our building automation system using *Intelligent Live Recommissioning*.

The benefits of automating adjustments, supervision, and reporting are:

- Aligning the operation of the building with the goals of the organization
- Better comfort
- Longer equipment life, and
- Lower energy costs

We can now see this revolution transforming our experience of the building environment. We can now get a better bottom line, and a greener, more sustainable building.

For more white papers like this :

1-855-SHIFT-60

info@shiftenergy.com

www.shiftenergy.com