Innovating the Business of Facilities Operations: A Framework for the Next Major Advancement in Facilities Operations

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ABSTRACT

Facilities leaders are under budget pressures that manifest themselves as a need to do more, limit headcount, go faster, and reduce energy costs. There is an urgent need to improve operations to meet these constantly increasing demands. Sound familiar? Then this article is for you.

Two main business facts form the core of this article.

First, businesses need to change, and make no mistake, operating a facility is a business. Incremental improvements happen continuously, but every once in a while there needs to be a quantum leap forward—something more revolutionary than evolutionary. Often, technology is an agent of change (PCs, internet, DDC, CAD), but it is only a catalyst. For major progress, facilities leaders must realize the need to do something very different, embrace the idea of innovation, and be willing to make fundamental changes to how the group operates.

Second, data are immensely valuable. This is true for every business function within every industry. Facilities operations is no different, just a little behind the curve. The facilities industry has focused its technology advancements on hardware efficiency and control technology, but still has not seriously embraced information technology (focus on information). The few that have operate in a different world than the rest.

The value of using data and information technology to advance the business of facilities operations has been proven. The examples and situations in this article are real, taken directly from various facilities

organizations. The use of data is a foundation that affects much more than just operational efficiency.

FOREWORD

Today's facilities are more highly instrumented and have more sophisticated control systems than ever before. So much so that we are generating more data than our people can assimilate. In addition, our occupants are changing the way they do business in shorter and shorter cycles as they strive to be on the leading edge of their business sector. It becomes increasingly important to truly understand how our buildings are interacting with and meeting the needs of the occupants.

This means that we must find ways to "expose" the data our buildings generate and find ways to present that information to building staff who can then diagnose operational issues before they become building problems, before the occupants even know anything is wrong. Our goal should not be to throw more people at the problem, but to find ways to use the power of technology to deliver better information to our existing staff to allow them to "virtually travel" through their building space and to quickly identify malfunctions. We must not be satisfied with concepts and practices that set up service desks and phone lines to receive complaints and then tell occupants that we will "be there when you need us." We must do our work closer and closer to "real time."

The good news is that we are starting to see software products that do not control things, but gather data with the idea that we should be doing something with those data. The technology piece may well be the easier part of this transition. But it is a transition we must make if we are to create "knowledge workers" of our building staff and in the process engage many more people in solving problems where they occur—in the buildings.

INTRODUCTION

Demands on facilities operations continually increase—improved comfort and air quality, lower costs (despite rising energy prices), new construction, green initiatives—but progress is not keeping pace with the

demands of business management. A few innovative facilities directors, unwilling to accept the status quo, have developed a strategy to fundamentally reinvent how their organizations operate. It is not just about how the HVAC systems perform, but how the business performs.

These pioneers are leading their teams out of reactive mode, helping them become proactive organizations. They understand that they are running a services business and know that to advance it, they must perform and progress on many fronts:

- Control HVAC systems operations to deliver space comfort;
- Reduce the annual utility bill;
- Improve the productivity of staff, from senior engineers to area mechanics;
- Teach technicians to fix problems instead of treating symptoms;
- Increase departmental credibility;
- Hold contractors and facilities staff accountable.

Budget pressures have made it necessary for facilities leaders to examine where they spend their limited dollars. Spending on individual productivity tools should be re-examined to see if there are more effective, strategic ways to spend those same dollars and advance the business in multiple areas.

There is a common denominator among the facilities innovators—they have embraced an advanced use of operational data throughout their organizations. These are not just data provided by a couple hundred data loggers or trend logs, but a complete historical record of all the operational data. This is a big difference, but periodically it takes this scale of change—in philosophy and approach—to transform operations rather than adding one more incremental improvement.

This article is about quantum improvements in departmental productivity, operational efficiency, design engineering, lower construction costs, preventative maintenance, accountability, and credibility—and how to go about achieving them.

THE CRITICAL ASSET REQUIRED FOR CHANGE

What asset are we referring to? In a word—data.

It is extremely rare to find a facility in any environment—academic, medical, commercial, residential—with anything approaching a

complete record of operational data. Many organizations operate under an erroneous perception that they have the data they need, because they have multiple systems that each collect some data and generate reports. In fact, building automation systems (BAS) typically offer woefully deficient tools, masked by an illusion of adequacy. Metering systems and utility companies are no better. Combining data from multiple sources, well, that is almost unheard of.

Consider this. Almost every facility out there has only one or two percent of the operational data easily accessible, and the majority of facilities directors don't even realize it. Most decisions are based on engineering assumptions and educated guesswork. Imagine a finance department operating on even half the financial data and guessing at the rest (they'd be in jail), or a customer service group with only a fraction of the actual customer and order data. Even auto technicians have data readily available; the car has data collection built in. To service it, the mechanic plugs in the computer and reviews the data—before ever picking up a wrench.

In contrast, the facilities world accepts its lack of data. This is partially due to the lack of understanding of its value, and partially because until recently, there really were no viable methods to have all the data all the time.

That is the critical asset required for change—all the data, all the time. Every single point from the BAS(s), meters (automated & manually read), utilities (interval consumption data & purchased utility bills), weather, maintenance and space planning systems, collected at consistent intervals (15 minute intervals work well), in a centralized data warehouse designed for efficient, flexible access to the information.

There is substantially more gained by applying data and information systems to operations than by adding more people. Data are assets that can leverage the existing knowledge of the whole operations staff. It is an order of magnitude difference. It enables facilities teams to make more and better decisions in less time, make the business go faster, and operate differently.

Facilities leaders and facilities staff that do not yet understand the value of data and the information derived from it often offer various excuses why they should not collect the operational data and build business-oriented information systems on top of it. Table 1 lists eight commonly heard excuses, or myths, about taking advantage of information.

Table 1. Operational Data Myths

Myth 1:
We already have all the data.

After talking to over 300 sites, we found only two that actually do have all the data. Others who perceive that they do are fooled by limited trending or report features that rarely can access more than 1 percent of all the operational data points.

Myth 2:
BAS trend logs are sufficient.

Where to start… see Myth 1. Trend logs degrade control system performance, severely limiting the number of trends possible. They don't combine data from other systems. They only keep data for a week or two. Hence you have a subset of the operational data, and most are hard to work with.

Myth 3:
Many of the BAS points are not important.

So why pay the BAS vendor to include them? Usually these "unimportant" points are for control. It is not sufficient to see what has happened, but you also need to isolate why, and can only do so by capturing control changes in addition to monitoring points.

Myth 4:
There is too much information to look at.

The point isn't for one person to read a 2,000-page listing of data points, but to make all data available when needed, and provide methods to monitor data quickly and easily, converting the raw data into information in the process. By involving dozens of people from across the facilities organization, it's easy to cover all critical operations, and you build the knowledge base of the staff in the process.

Myth 5:
We don't have time to look at the data.

The reality is that you already spend the time. Engineers typically spend 5X-10X more time gathering data than doing engineering work. The availability of information improves productivity. People will look if the time spent returns enough value and saves labor hours. Just look at the examples throughout this article.

Myth 6:
Existing systems already use a database, so we're covered.

There is a huge difference between having a good database manager, such as SQL Server, and a complete, functional data warehouse with all operational data made accessible.

Myth 7:
You can't trend everything without hurting control performance.
While true for BAS trend logs, collecting interval data and providing trend data for analysis is a separate issue. Software and communications standards, such as OPC, BACnet, LonWorks, and Web services are up to the task.

Myth 8:
Metering solves all data needs.
Metering does provide useful data, but it is expensive, slow to implement, and provides no operational insight explaining why consumption levels are where they are. Comprehensive BAS data collection provides far more actionable information, and can alleviate or postpone the need for meters with better return on investment and cash flow.

To reiterate, in order to achieve major advancements and revolutionary changes in facilities operations, one must have the operational data—period.

OPERATIONS AND MAINTENANCE

Operations and maintenance (O&M) represent a large portion of the daily work within facilities. Keep the occupants comfortable, maintain indoor air quality, and do so as cost-effectively as possible. Dozens of engineers, technicians, area mechanics and others combine to perform necessary monitoring, diagnostic, and maintenance tasks. Most operate in a very reactive mode (and have always done so), responding to customer service calls and addressing problems. This can change. A proactive facilities team is possible, and information is the basis to make it happen.

There is a perception by some facilities directors that they don't have the time to look at data—too much work, not enough hours, not enough staff. Wrong. Looking at data, which have been organized and presented as actionable information, is the only way to get ahead. Pick your cliché—work smarter not harder, do more with less, plan your work and work your plan—they all apply. Information is the way to leverage existing staff, get out of reactive mode, and provide superior service.

Comfort is Not a Luxury—Overpaying for It Is

Most facilities have standards for comfort that define acceptable

ranges for temperature and humidity. Some, such as hospitals, have far stricter air quality requirements. Improving comfort is typically more important than reducing energy costs. People's comfort complaints trump cost-cutting practices.

On a day-to-day basis, comfort is what influences the perception of facilities by the rest of the organization. Image and credibility rise when everyone is comfortable, and drop with the need for frequent hot and cold calls. Of course, while the facilities customers (occupants) are most influenced by comfort, upper management scrutinizes the costs. Information is the key to serving both masters.

Here is an example. An air handler serves adjacent spaces, one- and two-person offices, and printing/copy rooms where the equipment generates significant heat. Despite efforts by the technicians, there were often cold calls from the offices and hot calls from the printing rooms. Examining this air handler's data uncovered a discharge air temperature trying to maintain 50°F to provide cooler air to the printing rooms, which caused reheat to occur at the VAV boxes supplying the offices. The real problem wasn't temperature or air flow, which is what technicians had adjusted to respond to hot/cold calls, it was a balancing problem. The engineering assumptions for load were wrong.

Using information allowed the actual root problem (engineering design) to be identified and fixed, resulting in improved comfort for both spaces and lower costs by requiring less cooling for the air handler and less reheat by the VAVs. Plus, the data continuously verify the fix, enabling the facilities director to hold the engineering firm accountable to get it right this time.

As for the analysis effort to figure this out—to solve the comfort problem, which had been ongoing (and wasting money) for a year, took about 15 minutes looking at the data.

Cost-Based Optimization—the Only Kind that Matters

Few facilities departments actually know the run rate (i.e. $/hour) to operate their mechanical, lighting, and other systems. Due to the sorry state of information tools commonly in use today, most organizations pay 15-20 percent more to their utility companies for HVAC than necessary.

Operators take actions every day that can affect cost and comfort, but don't have the information to make informed decisions. A well-intentioned change to a chiller may impact cooling towers, secondary

pumping, or air handler operations. The only way to know is to be able to see the data—see how operations and costs are affected system-wide. The goal is not to make equipment run better, but to make the system run well.

Cost-based optimization is a fantasy without complete operational data. Missing information skews the results and can lead to poor control decisions. However, data provide the information to know, for example:

- Which chiller combinations operate at the lowest cost per ton-hour at on-peak versus off-peak hours.
- When to use gas versus electric chillers.
- The best control strategies for cooling tower fans.
- The impact of addressing a hot call by increasing air flow versus decreasing air temperature (or if the real problem is something else, like a broken reheat valve or a design problem as discussed above).

The basis for cost-based optimization is conceptually simple, but complicated to implement. First, use the operational data available from the BAS(s) and meters to calculate energy consumption for electricity, gas, and other utilities. Then, model the utility rate structures in all their complexity (multiple rates, time-of-day pricing, and other determinants as appropriate) and calculate operational costs. With this model, facilities directors can know what the cost per hour is to run the facility, each system, sub-system, and piece of equipment, recalculated every 15 minutes. Operational changes can be tracked to verify not only the impact where the adjustment was made, but of ripple effect changes anywhere in the system. Knowing costs every 15 minutes is a different world than receiving a utility bill at month's end—with immediate information you can take action to affect the problem. Thirty days later is too late.

Interactive Commissioning—
Verifiable Results at a Fraction of the Cost

Commissioning of all forms (new construction, retro- or re-commissioning, Continuous Commissioning®) suffers from the same basic

three issues: 1) the labor cost to do it is very high; 2) building owners have yet to see enough proof of the value and ROI to risk that cost; and 3) there is even less proof that gains realized through commissioning will persist. Interactive commissioning uses data to combat all three of these concerns.

One person can interactively commission more equipment in a week through the data than a typical commissioning team can during the entire project. Commissioning agents often sample equipment, for example, commissioning only 10 percent of the VAV boxes because the labor cost to do them all is prohibitively high. Facilities directors should not tolerate this. Find an agent willing to use the data and do a thorough job. Hold the commissioning agent (and the contractor if there is new construction) accountable to make the equipment meet operational requirements, not merely pass some functional tests. Pay the contractor after systems pass operational tests. This is not affordable with a labor-based process, but you can do it with an information-based approach.

This example shows the impact of information on retro-commissioning 115 air handlers. An air handler optimization resulted in a $1,200/year savings (cooling, heating, and fan savings). The estimated savings across 115 AHUs was $500-$1,500 annually, with an average of $750, per air handler. That is $86,250 currently going to utility companies that is wasted.

Using data, one person evaluated 115 AHUs in less than three days. The evaluation documented whether each AHU was meeting comfort requirements and operating as cost effectively as possible, and listed recommendations for improvements where needed. While most directors suspect problems exist, evidence allows them to take corrective action—to create a plan to systematically address each issue and stop throwing money at the utility companies. The data are the evidence.

Compare those results to not using the data. A commissioning firm (and/or internal staff) working to produce the same analysis would spend 50+ person-days crawling around the building with data loggers and in the end have less information and no good way to verify results. That labor cost is prohibitively high, and the commissioning never actually happens.

The only way to attack this kind of problem is with information. Verification that fixes had the intended results is fast and based on hard engineering facts, not estimates. Ongoing monitoring of the data ensures persistence. At the same time, optimizing the air handlers likely

reduces hot/cold calls and improves customer satisfaction.

Facilities directors who are happy with the status quo can continue to send the utility companies an extra $7,000 a month. Those looking to reinvent their operations can do so through information, and keep that "bonus" money in their own budget or return it to the bottom line.

Preventative Maintenance Today Stops Disasters Tomorrow

There's no doubt that preventative maintenance is beneficial. From a financial point of view, various institutions have calculated that spending a dollar on preventative maintenance eliminates the need to spend four dollars later on deferred maintenance. Then there are the less tangible benefits—avoiding disasters such as the heat failing on the first cold day of winter or earning a reputation as a facility that constantly breaks down. Continual monitoring of operational data will better inform and prioritize preventative efforts so that fewer issues are ever noticed by occupants and tomorrow's disasters never materialize.

Add 20 Percent to Equipment Life

Even while meeting comfort specifications, it is not uncommon to find equipment trashing, cycling, and hunting once one looks at the data. Well-maintained equipment that runs smoothly will last as much as 20 percent longer—no rocket science there. But without information, it is almost impossible to know if equipment is being beaten into an early grave. With data, you not only can see if problems exist, but you can easily diagnose, fix, and verify the results.

MANAGEMENT AND CREDIBILITY

The facilities director's role is in large part about leadership. It is not limited to engineering leadership, but includes managing a business environment that makes constant demands:

- Can you eliminate some headcount?
- Here's some additional space to manage.
- When are you going to upgrade that legacy equipment?
- Meet these new environmental requirements.
- Can't you go faster?

All of this goes on while energy costs rise and the systems managing energy get more complex. Spending limited available dollars wisely

is an important skill for facility leaders. Money spent ineffectively compounds the problem, but spent intelligently allows one to navigate their way to smoother sailing.

Leadership is more than budget allocation. It includes the management and effective utilization of staff, and shaping the group's image viewed across the organization. The credibility of the facilities group rests with the director, whether through direct interaction with executives or management practices that dictate how the team serves its customers. Tapping into the operational data asset is a powerful tool to lead the group to major improvements, increased respect, and credibility on all fronts.

Lead Staff Out of "Reaction Mode"

Operations staff spends too much time working on the wrong things. This is what happens when you live in "reaction mode." Area mechanics spend hours walking through their building(s) gathering what is actually a small amount of information. Engineers spend much more time collecting the data they need for analysis than doing actual engineering. Everyone chases today's problems and treats the reported symptoms. But there is a path out of reaction mode, and it is in the data.

For example, with a well-structured view of building data, area mechanics can perform a "walk through" in about eight minutes of looking at the information. They can see what happened overnight, know how each air handler and terminal box is operating, know if the lights came on at the proper time, etc. Data provide the information to properly prioritize their work and frees up time for preventative maintenance tasks (which are also well-defined and prioritized using the data).

In a world with data, area mechanics, engineers, technicians, and operators all spend more time implementing proactive tasks, and significantly less time gathering the data to make the decisions.

Win Back Control of the Operations Budget

CFOs like numbers—it's the world they know. Facilities directors have lived in a world of estimates. No wonder it is often hard to deal with the folks that hold the purse strings. Time for a change.

With a complete record of operational data, with irrefutable facts, facilities directors can change their relationship with the CFO and be in control of the operations finances instead of being controlled by them.

Think how differently the next annual budget cycle or capital improvement request would go if armed with hard data that:

- Quantifies the waste to be corrected by a redesign;
- Verifies that a retrofit will have the intended result;
- Proves that a chronic comfort issue needs funding to address;
- Measures operational savings achieved by the facilities team in the past year; and
- Demonstrates an unprecedented level of customer service.

Directors can use information to consistently measure and improve operations in ways that were impossible before. When armed with such facts, they cannot only demand accountability from subordinates, but also accept accountability for operations' performance when dealing with upper management. The director that does this will change the rules of dealing with the CFO, win many more budget battles, and see his or her credibility soar with executive management and across the organization.

Build Departmental Credibility and a Culture of Accountability

This article has repeatedly made the point that operational data provide a means for accountability, and that improvements made will lead to credibility. However, do not leave this to chance. Accountability must become part of the culture and credibility nurtured once earned. Data can help.

The advancements discussed above in comfort, customer service, operating costs, proactive maintenance, staff utilization, and fiscal management offer major gains in credibility. Some are more visible to customers, some to management, but all are important. With this kind of success, there is nothing wrong with some self-promotion—especially when the promotion provides a valuable service and further adds to the group's credibility.

Energy consumers, department heads, building executives, and senior management all have vested interests in certain operational data (whether they express it or not). Publishing information suitable for each of these constituents is another path to increasing facilities credibility. It shows that the facilities group knows how systems are running and has the facts to back them up. It also sends a message to upper management that the operations group is proactive and can be responsive to additional information requests in the future.

Beyond the communications aspects of publishing pertinent information, engaging management and users is likely to affect their behavior. With increased credibility, facilities leaders can completely transform relationships and build a culture of accountability within and beyond the operations group, for example:

- Reassign partial responsibility for energy consumption to the users.
- Change the ground rules for dealing with finance and purchasing, and justify budgets more easily with the CFO.
- Promote optimization gains achieved per building and within the central plant, recognizing both behavioral changes by occupants and operational improvements by facilities staff.
- Directly account for, and show the value of, each staff member.
- Verify the effectiveness of design engineers and commissioning agents.
- Educate customers about the consequences and costs of their decisions and actions.
- Develop the support and admiration of the trustees.

All of this is only possible in a world of data that provides irrefutable facts. Otherwise, it is a land of estimates and conjecture that will soon be unacceptable as top management demands more.

ENGINEERING (RE)DESIGN AND CONSTRUCTION

Estimates are that half of all redesign projects that do not address the problems originally targeted. This suggests that either half of the design engineers are incompetent (unlikely), or that they work with too little factual operating data to precisely know the problem. Like technicians, they often address the symptoms.

Engineers design for worst case conditions. They err on the side of over design. It is easy to see how this happens; after all, an over-designed system might be wasteful, but an under-designed one won't perform and that will come back to haunt them. Plus, there is very little accountability for poor design. The bottom line to the facilities director is that the chances of paying for an over-designed system are pretty high, which will insure higher construction and operating costs. All for

the lack of good information.

Facilities directors should require design engineers to use operational data and prove that redesigns are effective at solving existing problems and are not over-designed. The same is true for new construction, where over-designing and over-building mechanical systems is commonplace. With operational data, designers have the ability to truly assess existing designs to see how they work in the field. This feedback, which does not exist today, will influence the use of systems and equipment in new designs.

Data hold the key to design and construction accountability. If you have operational data to feed the design process and later validate the results, design engineers and mechanical contractors have the information to do the job correctly, and can and should be held accountable for their results.

COST ALLOCATION AND UTILITY BILLING

Operational (demand side) and utility (supply side) data, combined with space planning information, can enable an organization to perform detailed energy cost allocation by space, department, or cost center. The data must be present to determine space consumption, and then rates can be applied to generate accurate costs for each space. This approach more accurately assigns costs to actual energy consumers as opposed to a simple square footage allocation.

One advantage to accurate allocations is that it holds high energy consumers accountable for their consumption instead of subsidizing them by the low energy consumers, the typical approach. This approach places the responsibility for energy consumption squarely at the feet of the users. However, it requires a utility bill with operational data that shows the user where issues may exist and what actions to take to reduce costs in the future. The tie between operational and billing data also equips the facilities team to assist departments/cost centers with questions about their allocation and further explore strategies to reduce consumption—another chance for the facilities group to earn a reputation for outstanding service.

When asking for departmental accountability, timeliness of information is important. A system that only supplies data in the monthly utility bill puts everyone at a disadvantage. While the facilities group

may have no problems correlating billing data to operations for any specific period of time, it will be nearly impossible for department heads to correlate operations to actions from weeks ago. Publishing month-to-date (updated every 15 minutes) billing estimates based on operational data makes the information available to all concerned. Now facilities customers can review current information, associate actions with consumption, and change behavior.

UTILITY PURCHASING

Purchasing energy is a complex task that requires a thorough understanding of demand. Minimizing energy costs requires insight into how to manipulate the timing and height of peaks in demand. Because energy pricing structures change regularly, effective purchase negotiations require a sound knowledge of the energy market's price drivers to "lock in" the best price.

Using operational data can provide knowledge and insights into the institution's consumption patterns, the drivers of these patterns, and the impact of the weather. Additionally, the information can help participation in demand response programs, many of which have financial incentives. Utility buyers can negotiate far better energy rates and avoid expensive ratchet charges when armed with the data.

Another area where data can assist in driving down utility costs is sewer charges. Cooling towers evaporate significant volumes of water. Operational data can, quite accurately, calculate this water loss, which never enters the sewer system. When water and sewer are not separately metered, some organizations have successfully negotiated reduced sewer charges using data.

Finally, many organizations deploy expensive metering systems that parallel utility meters for the purpose of verifying the utility bills. Instead, operational data can summarize energy usage, identify losses, and provide supporting documentation to reconcile discrepancies with the utility—all at a fraction of the time and cost.

CONCLUSIONS

HVAC and electrical systems account for 20-25 percent of the value of building assets (based on replacement costs). Yet it is rare to find a

facilities department with a complete historical record of operational data that shows how those systems perform. Ironically, this is exactly the path to solving many of the largest problems facilities departments face today.

The business climate for facilities is the most difficult it has ever been. More demands, more space to manage, less staff, rising costs. Facilities directors find themselves trapped in a fog of issues without the ability to see a clear path forward. Information enables them to map a course and drive the business forward.

The investment in an information infrastructure is one of the few ways a facilities leader can advance the business on multiple fronts. Most dollars spent for improvements go to individual productivity tools where the value and return on investment is one-dimensional. With the asset of data, not only does it provide value directly, but it also enables better-informed decisions and prioritization for other expenditures.

Data, and the actionable information they provide, are the tools for facilities directors to demand accountability from internal staff, external contractors, customers, and themselves. When operational performance, customer service, and information distribution make leaps forward, the credibility of the facilities operations group ascends to new levels as well.

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