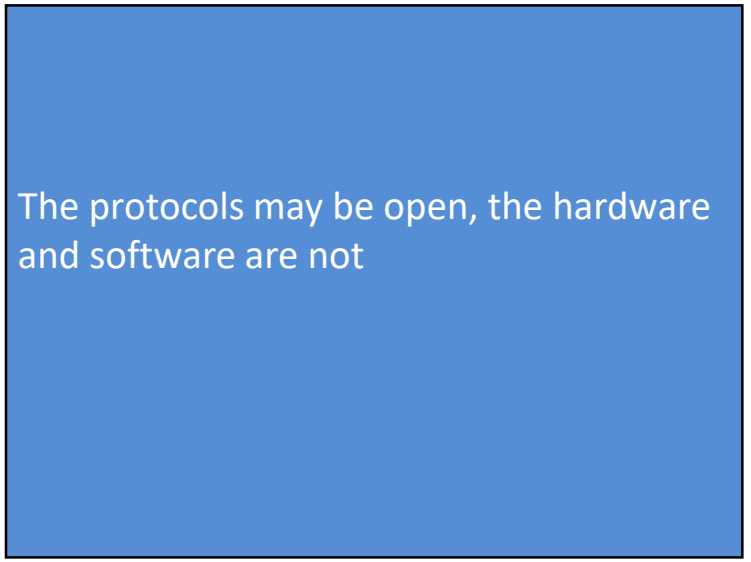
Of course it's impossible to predict the future, and I'm quite likely to be wrong about most, If not all of this.

It's a time of great change in the automation industry. There are a lot of trends, and even more buzz words, pulling things in different directions. Remains to be seen which of these trends will stick around.

My objective today is to hopefully expose you to a few new ideas and concepts that you may not have thought much about before, and lay out a case for why I think these are important ideas that will shape the automation industry in the coming years. Some of this may take a long time to become commonplace, if ever, but regardless I think there is merit in considering the potential impact.

In particular, I'm going to look at how these developments can help to overcome some of the key limitations of current control systems.



Why does this matter?

How would you feel if you had to recreate your power point from scratch every time you switched from Lenovo to Dell?

This is where we're at with controls. Have you tried programming a delta controller with RC studio? Of course not, that statement seems absurd to anyone who knows controls. But what if we could? This is how the IT industry works. Hardware and software are not this closely coupled, and separating these are part of the future of our own industry. Open source is common, and used in commercially significant deployments.

Able to marry best in class hardware with best in class software. Open doesn't just mean open source. Rapid innovation, because now you could focus on just one aspect and specialize, without having to have a whole control system. You could be a software company that just produces a really fantastic optimal start program.If the framework was in place for that software to be able to easily integrate into control software, through robust APIs for example, think about how much this would speed up the pace of change.

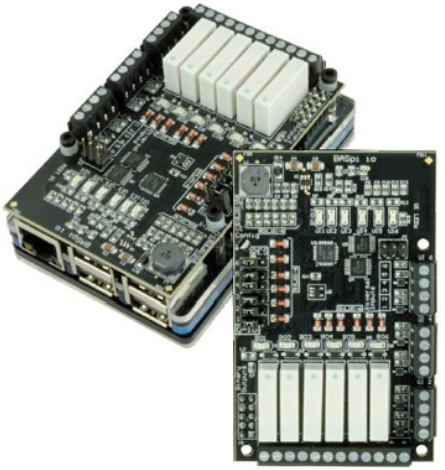
Of course this creates new challenges to overcome, how do you ensure quality, how do you make sure things work together correctly. Valid concerns, but they can be overcome, with standards for APIs for example. Again, other industries do this all the time.

The elements required to achieve something like this are already starting to be commercially available

Raspberry Pi

Some of you may be familiar with the raspberry pi. Inexpensive ($35) computer

Pi with a HAT



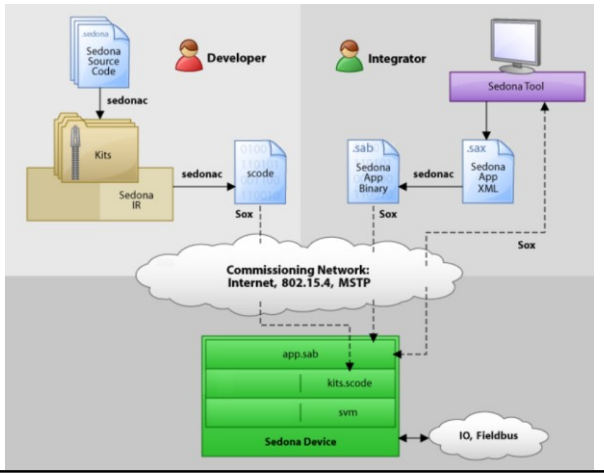
Hardware added on top –Made by a major controls vendor. Gives you 6 inputs and 6 outputs, they also package it in a box that's easily DIN rail mounted, 24V AC.

Targetted at the training market, as well as home automation and for small commercial jobs.

A powerful and flexible controller for $200. Does IP via ethernet or wi-fi. Havin the hardware capability of a high end Jace, which costs thousands.

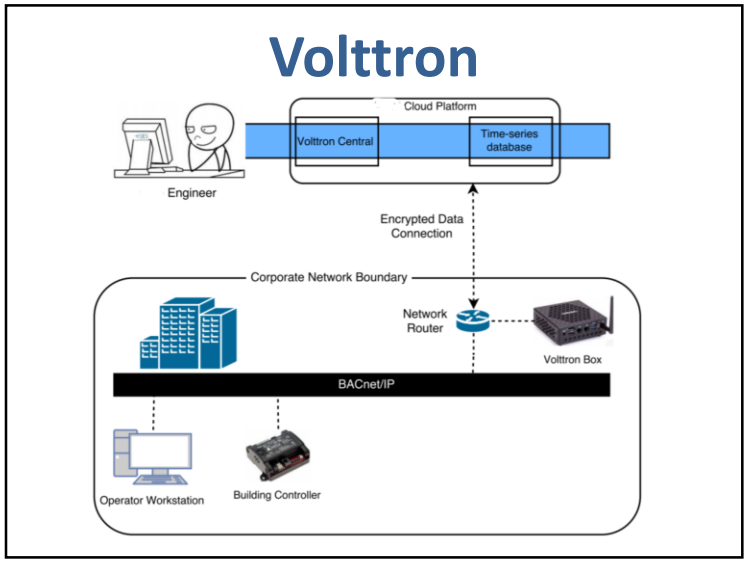
A case of both open hardware and open software. Comes packaged with Sedona, open programming language.

Sedona



Open source programming language – Offshoot of Niagara

Widely used in education, supported by a few manufacturers in their controllers.



DOE open source project, started around application for smart grid, but is a platform for acquiring BAS data. Can be installed on just about anything, gives you full access to time series BAS data, which can then be stored in an offsite database. Cheap and easy long term trending when paired with open source visualization and analytics tools.

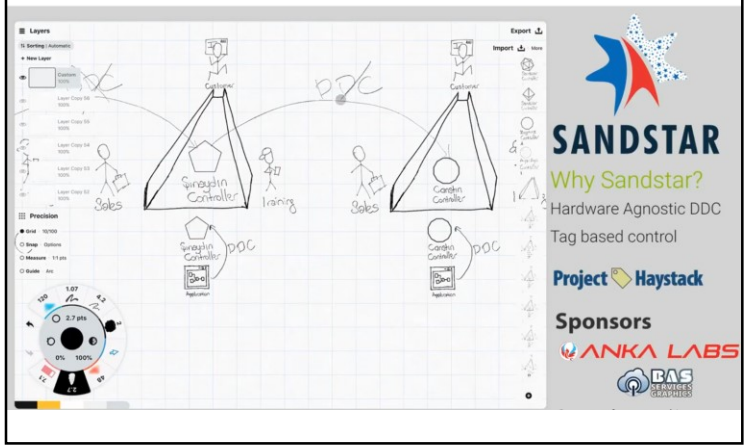
Something we started using after playing with some alternatives, including one that was perfect, until the company stopped selling it.

Another huge benefit of open controls, ability to have control over the devices, and not necessarily be at the whim of companies who might decide to discontinue products.

Combine the volttron platform with free open source visualization tools, Grafana shown here,

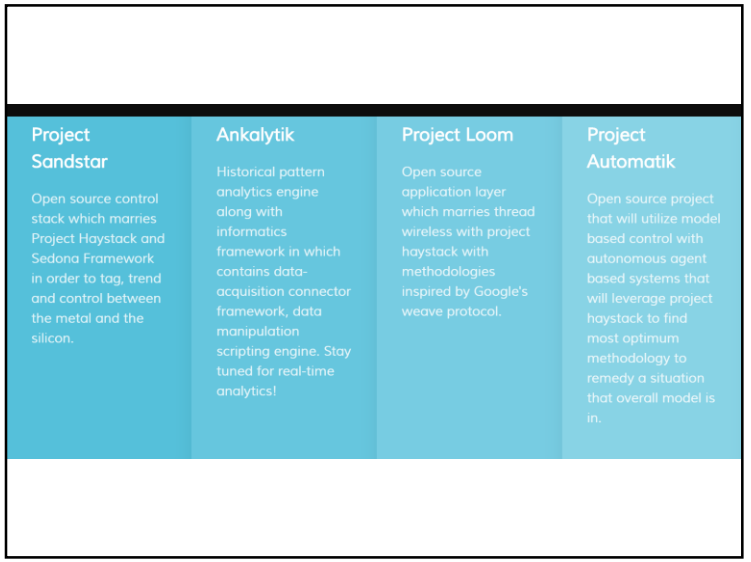
Another piece of the open source community, has been around for awhile, is project haystack. Haystack is an open source schema for point tagging and meta data. Being widely embraced by more vendors. Something like this is key to making analytics software more accessible as it greatly speeds up the process of mapping spo that your software can correctly interpret the data. Haystack lets the software know what things are.

Project Sandstar



Open source project to create truly hardware agnostic controls software, using Sedona and haystack.

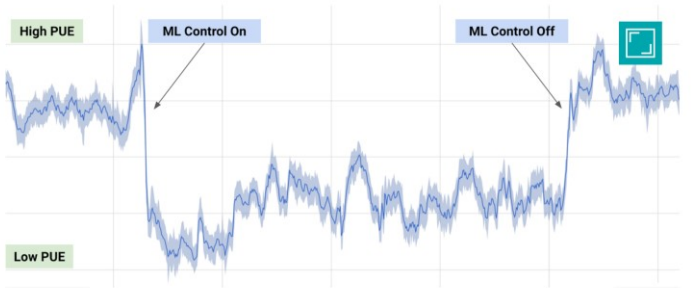
The idea being that you could use the same software on supporting hardware, regardless of manufacturer.



Developer of Sandstar also starting other interesting open source software initiatives, aimed at making BAS data more accessible, and pushing us further away from proprietary software solutions. Automatik aiming to replace sequences of operation with madel based control that allows for true optimization.

With hardware this flexible you will no doubt see a lot of innovation. Particularly, you could start seeing inexpensive AI, or model predictive control start to replace traditional control programs and sequences of operation. There is no doubt in my mind that sequences of operation will one day be replaced, especially for large central systems. Already in place for chiller plants, not only cases of proprietary algorithms, Hartman loop, Lobos, etc. but true AI.

DeepMind AI Reduces Google Data Centre Cooling Bill by 40%

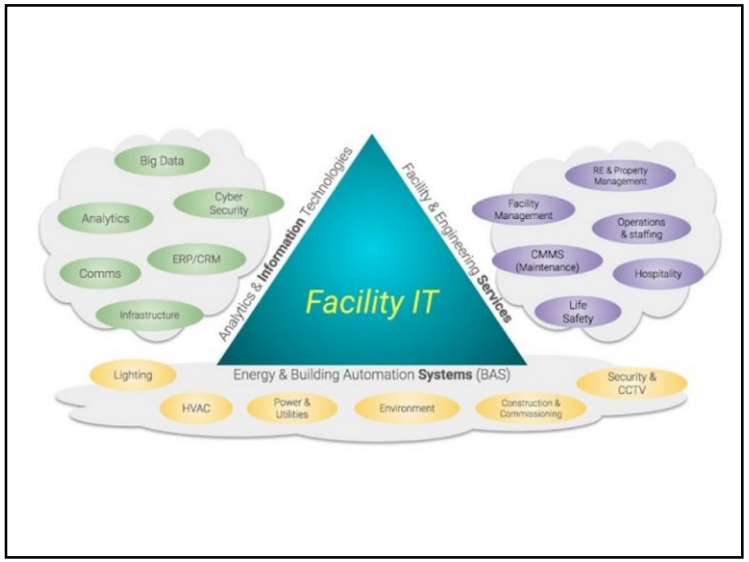


There is a lot of value to be unlocked in opening up the BAS to share data

BACnet networks can be slow for applications requiring lots of data

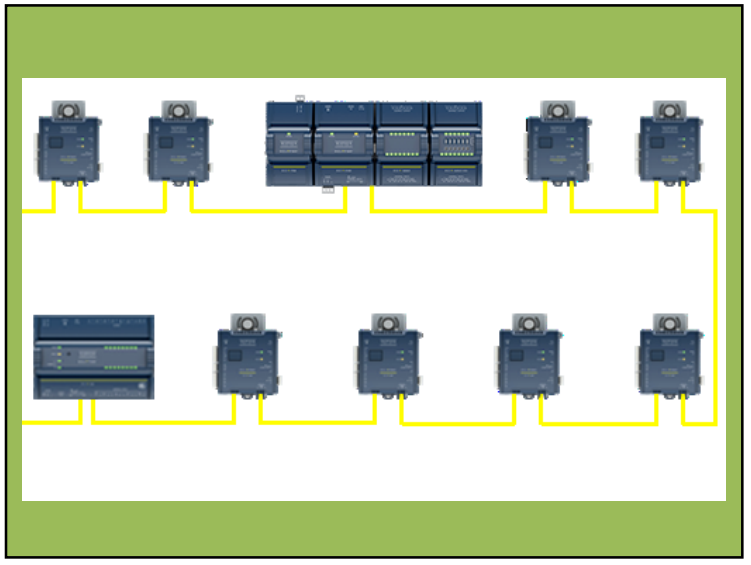
BAS not considered “secure enough” by corporate IT

I am going to give a bit of an overview on a few technologies that are already changing how we operate buildings, and project a bit into the future regarding how these capabilities might combine and evolve to radically change how we design, commission and operate buildings in the future. I will talk about a few products that I’m familiar with, there are many more that I could have included, and still more I probably don’t even know about. Not meant to endorse specific products or services, but just to provide a concrete sense of what is possible.



A lot of value to be unlocked by having BAS be able to share data seamlessly with other building networks and applications.

e.g. CMMS, hospitality, booking and scheduling, analytics, list goes on.



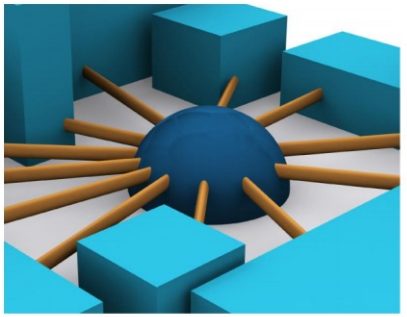
Networks moving towards flat IP configurations. Now common to have controllers with 2 ethernet ports to allow for daisy chain topologies, reducing that traditional cost premium for IP. IP controllers also coming down in price, with at least one manufacturer telling me there was no difference in cost between their MSTP controller and IP version.

IP network more vulnerable to cyber security risks.

BACnet Secure Connect

A Secure Infrastructure for Building Automation

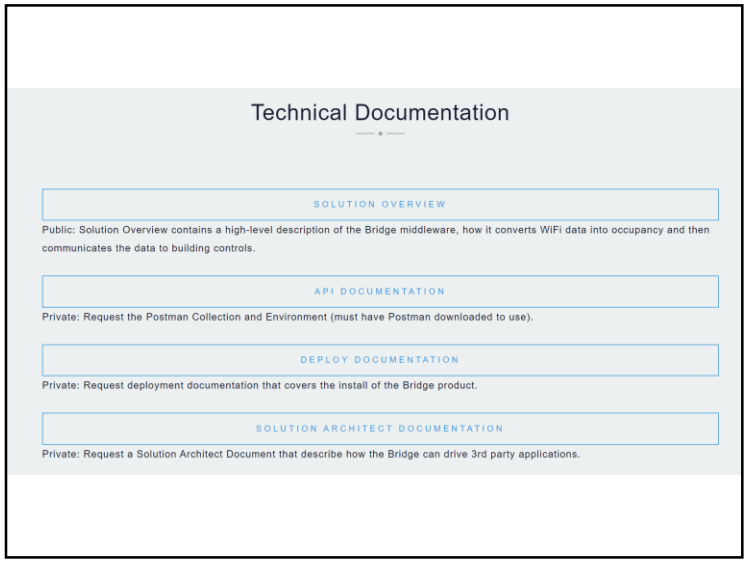
David Fisher
Bernhard Isler
Michael Osborne
SSPC 135 IT Working Group



Increasing BAS value through data sharing

Talk now about some work that's been done around using IOT solutions for determining building occupancy.

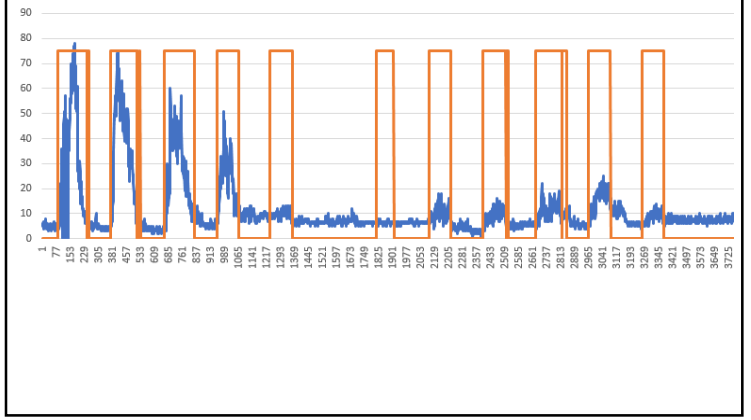
We can do this in buildings now, based on IT traffic. You can figure out to a high degree of accuracy where people are logged onto your network.



API made available to 3rd party developers – this is what the future looks like.

Make their API available upon request, so that others can write programs that make use of their data. Needs to be that easy for BAS.

Modelled AHU Operation



Used an approach that some refer to as digital twin. Took the data (few weeks worth) generated by SBS's system which was mapped onto AHU zones, then look at how the AHU would operate under the revised sequences, before actually implementing any changes.

Modelled Savings

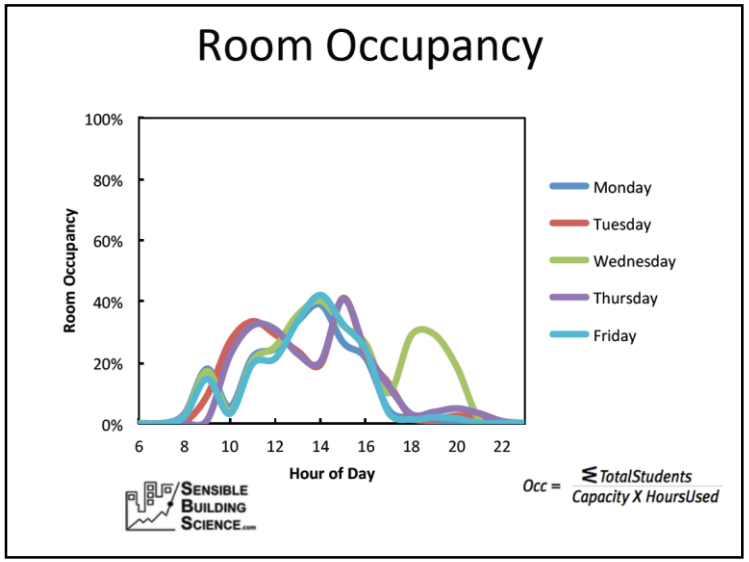
		Baseline						Wifi Occupancy Sensing Projected Savings				
Ventilation System	ECM	Gas (GJ)	Mech Heat/Cool (kWh)	Fan (kWh)	Average Daily Run Hours	Annual Energy Cost	Cost/hr	Average Daily Hour Savings	Gas (GJ)	Mech Heat/Cool (kWh)	Fan (kWh)	Cost Savings
AHU-1	AHU Start/Stop Control	730	0	60,861	10.6	$9,912	$2.50	0.5	51	0	4,289	$699
AHU-1 Floor 2	Floor Isolation	148	0	25,580	11.1	$2,774	$0.69	3.4	46	0	7,884	$855
AHU-1 Floor 3	Floor Isolation	148	0	25,580	11.1	$2,774	$0.69	2.3	31	0	5,309	$576
AHU-1 Floor 4	Floor Isolation	139	0	23,981	11.1	$2,601	$0.64	2.3	29	0	4,977	$540
AHU-2 Floor 1	Floor Isolation	57	0	9,681	11.1	$1,059	$0.26	3.3	17	0	2,844	$311
AHU-2 Floor 2	Floor Isolation	171	0	29,043	11.1	$3,177	$0.79	1.8	27	0	4,639	$507
AHU-2 Floor 3	Floor Isolation	171	0	29,043	11.1	$3,177	$0.79	2.8	44	0	7,436	$813
AHU-2 Floor 4	Floor Isolation	171	0	29,043	11.1	$3,177	$0.79	3.6	56	0	9,541	$1,044
AHU-4	AHU Start/Stop Control	165	0	44,535	8.6	$4,013	$1.27	0.0	0	0	0	$0
MZU-1	AHU Start/Stop Control	11	0	11,323	8.9	$751	$0.23	0.4	1	0	512	$34
MUA-4	AHU Start/Stop Control	1	0	1,294	8.9	$85	$0.03	1.7	0	0	249	$16

Devloped energy model for each system, helped by access, to a large data set on operations from Skyspark analytics package. Able to quantify expected savings for various strategies at the AHU level.

Gave the client confidence in the investment

Provided priority list for guide implementation

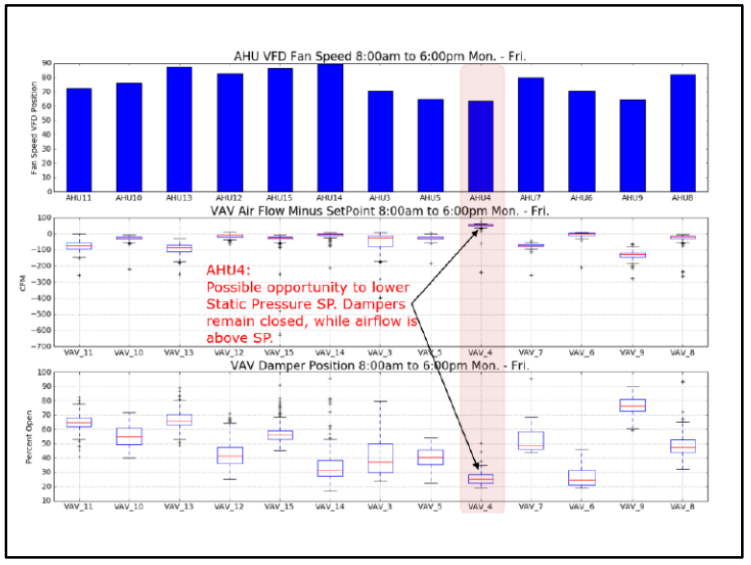
Provided data to validate real performance against, and for troubleshooting once the changes had been made for real.



Space planning implications. Not only knowing it's occupied, but how occupied.

Reveals significant excess space, this can inform decisions on scheduling, or even how to build future buildings smarter. This can also provide great data for a building, for example, considering a move to hoteling or hot desking, how mu

Other sources of this info as well. Telus Garden – Look at desk bookings to determine operation how much space do you really need?


AHU VFD Fan Speed 8:00am to 6:00pm Mon. - Fri.
Fan Speed VFD Position
AHU11
AHU10
AHU13
AHU12
AHU15
AHU14
AHU3
AHU5
AHU4
AHU7
AHU6
AHU9
AHU8
VAV Air Flow Minus SetPoint 8:00am to 6:00pm Mon. - Fri.
CFM
AHU4:
Possible opportunity to lower
Static Pressure SP. Dampers
remain closed, while airflow is
above SP.
VAV_11
VAV_10
VAV_13
VAV_12
VAV_15
VAV_14
VAV_3
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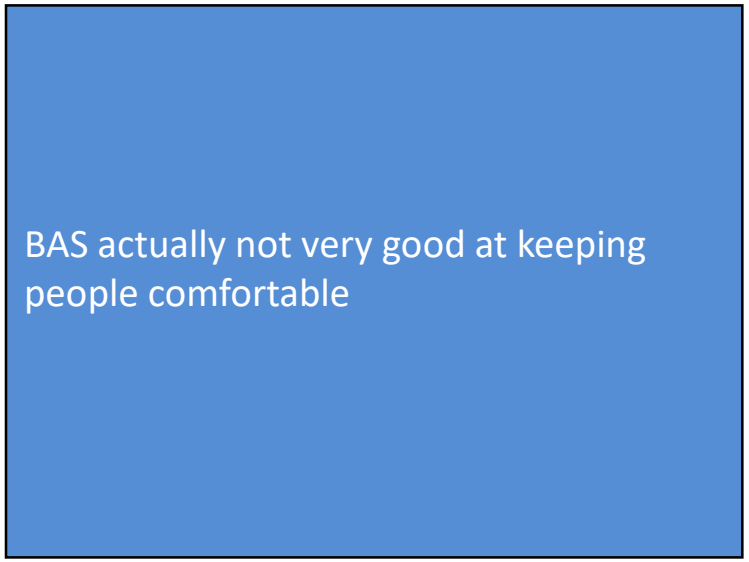
VAV Damper Position 8:00am to 6:00pm Mon. - Fri.
Percent Open



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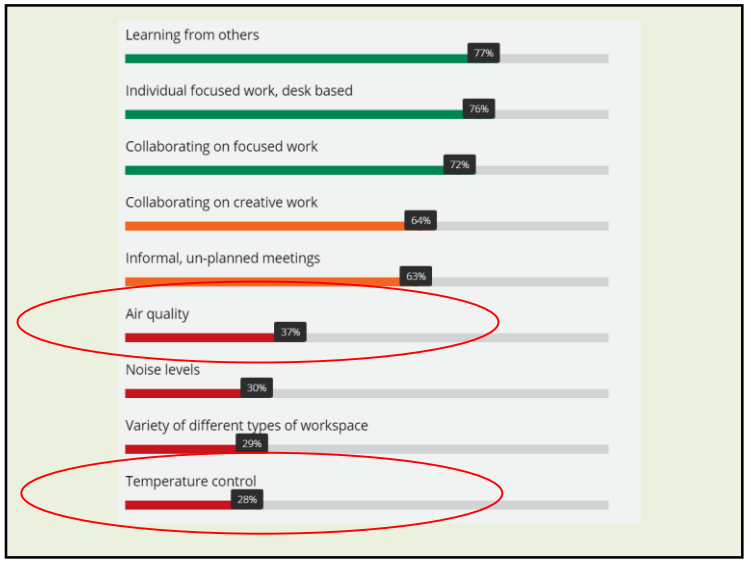
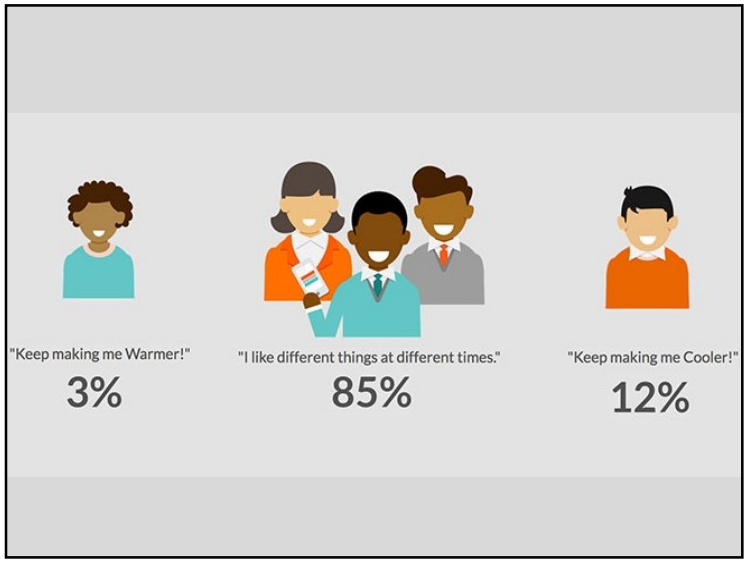


By and large, people are VERY dissatisfied with system performance.

They don't feel much better about air quality. They are most dissatisfied with noise levels and sound privacy, and this is worse in most green buildings.

Buildings are funny, it's not easy to go out and get a new HVAC system, or even to relocate if you're a tenant. That has resulted in designers and operators not paying as much attention to the occupant experience as we should. That level of satisfaction in most other products, like cars, would drive away customers. No one really thinks to ask about the user experience of the HVAC system when looking for a building. Heck, even when designing a building this isn't a top consideration.

Majority of occupants are dissatisfied with temperature performance. This is one of the main job of buildings, and we've been working on this for 100 years. Other aspects they are happy with, quality of the space, light quality, etc.



Personalized Controls

HVAC by engineers, vs HVAC by psychologists and behavioural experts.

On the right is Comfy. It provides an app or web interface, you tell it how you feel about your space, too warm, too cold, just right, and it “does the rest” so to speak. Collect that data, feed it into algorithms that connect directly to BAS, use it to refine or adjust setpoints. It learns patterns to start preemptively making changes, figuring out over time how people like their space. Say you tell it you’re too warm, depending on the systems, it will even give you a little blast of cool air, just so you know it heard you. This isn’t how engineer’s program systems. We all know that whether or not a building is meeting setpoint can be almost irrelevant as to whether people are “comfortable” in their space. This takes into account the psychology of it, people’s desire for control and to be listened to, important aspects of comfort that are often not taken into account.

83% increase in occupant satisfaction

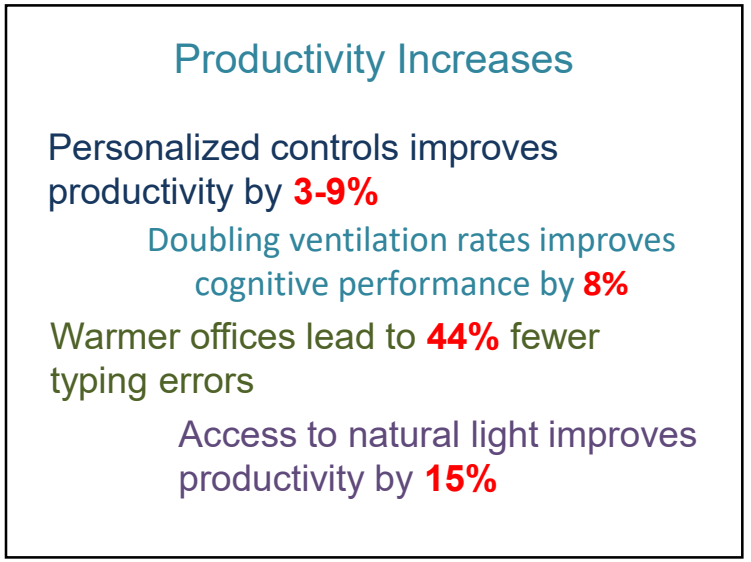
Personalized Controls

83% increase in workplace satisfaction

90% reduction in hot/cold complaints

15% energy savings

Results can be dramatic



There is a growing body of research demonstrating that the building environment can have significant and measureable effects on various aspects of employee performance which ultimately impacts productivity including cognitive performance, absenteeism, turnover, and satisfaction. Significant impacts on productivity have been found to be linked to ventilation rates, space temperature, personalized controls, and lighting quality.

Buildings are about the people!

Plug for automatedbulidings for more info.