Ongoing Commissioning

What is ongoing commissioning and how can it impact building performance?

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The Canadian construction industry is changing; to tackle the challenges of dwindling global resources and the growing impacts climate change, building sustainably has become a high priority to building owners and occupants alike. As the sustainable building market expands and policy shifts to require energy and water usage reporting to achieve higher performance targets, building commissioning has emerged as one of the most cost-effective and low-risk strategies for reducing energy consumption, energy costs, and greenhouse gas (GHG) emissions [1]. ***But what happens to a building after commissioning is complete?***

Most buildings will lose up to 30% of their efficiency in the first three years of operation [2]. Building performance degradation is due to a multitude of possible faults, including but not limited to: manual overrides of reset schedules, leaking control valves, inoperable economizers, and deferred maintenance issues [3]. That's where ongoing commissioning (OCx) comes in.

> ***Ongoing commissioning*** *is a process designed to continually track the performance of a commissioned building to ensure that the benefits obtained through the preceding steps (new build commissioning, retro-commissioning, or re-commissioning) are maintained over the life of the facility* [3].

An ongoing program provides a method to continually improve building performance. It's tailored to each unique building's daily operational needs and performance goals.

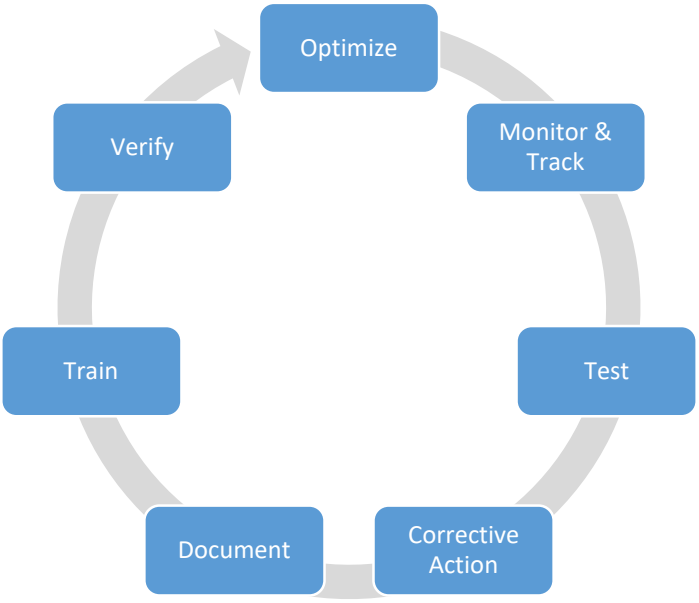
Ongoing Commissioning Drivers

The benefits of ongoing commissioning extend beyond efficiency loss prevention. Other potential drivers that building owners and operators might have to implement ongoing commissioning include the following [2].

- Reduced energy consumption
- Reduced energy and operating costs
- Up-to-date and accurate facility information
- Extended equipment life
- Reduced maintenance costs (including emergencies, scheduled teardowns and secondary damage)
- Reduced greenhouse gas emissions
- Constant facility data analysis
- Reduced unscheduled downtime
- Proactive and predictive analysis of problems (rather than reactive)
- Quality assurance for warranty and recurring problems

In addition to these benefits, ongoing commissioning is beginning to pop up in green building rating systems. LEED v4 for Existing Building Operation and Maintenance includes an *Ongoing Commissioning* credit under the Energy and Atmosphere (EA) category and two related credits (EA credit: *Existing Building Commissioning - Analysis* and EA credit: *Existing Building Commissioning - Implementation*).

The Ongoing Commissioning Process



*Ongoing commissioning is a **cyclical process** intended to be implemented over the life of a building. It allows building operations staff to gain insights on performance and allow for **predictive analysis and proactive action** rather than reactive maintenance and repair* [4, 5].

OCx Step 1: Building Optimization

The first step in the ongoing commissioning process is to ensure the building is performing optimally in terms of energy efficiency and thermal comfort. Optimal performance is achieved through commissioning for new buildings or retro/re-commissioning for existing buildings.

OCx Step 2: Monitor and Track Building Performance over Time

After the building has been confirmed to be meeting performance goals it should be continually monitored using the following key performance indicators: energy consumption; energy demand; space conditions (temperature, RH%); equipment efficiencies [4, 5]. These indicators will help to give an overall snapshot of building performance at any given time.

There are several building performance monitoring and tracking tools that range in complexity and implementation cost - four of the most common are described herein [4, 5, 6, 7].

Benchmarking is the simplest and least expensive performance tracking tool and is used to: compare a building's energy use intensity to other, similar buildings or year over year for the same building. All that's required for benchmarking are utility bills and, for comparison to other buildings, a database tool such as Energy Star. The disadvantages of benchmarking for performance tracking is that it doesn't identify specific areas for improvement and thus does not help in preventative maintenance. It also cannot be used to predict the impacts of energy efficiency upgrades.

Energy information systems (EIS) are another performance tracking tool. An EIS monitors and collects energy data/usage trends and can be used to conduct utility analysis, which often includes benchmarking. This type of tool is very useful for tracking portfolios of buildings. Many EIS have the ability to program custom alarms if energy use anomalies are detected. Despite these advantages, an EIS is only as useful as a building's submetering system is granular; in many buildings, energy is metered at the building-level only. In these cases, energy consumption or demand anomalies cannot be pinpointed to be occurring as a result of malfunction of any particular system or piece of equipment; the EIS would only indicate that there is a problem somewhere.

Building automation systems (BAS) are used to automate building equipment and controls, and can also be used to track the performance of building mechanical systems and equipment. With alarm and trending capabilities coming standard, BAS are very useful for troubleshooting. However, BAS do not typically track energy usage so the energy resulting cost impacts of under-performing systems or equipment remains unknown. This shortcoming precludes the BAS from being of much use in repair or upgrade prioritizing.

Fault detection & diagnostic (FDD) tools are the most sophisticated widely used performance tracking tools currently available. FDD monitors BAS data in real time and identifies faults using programmed "rules". For example, if an air handler's discharge air temperature feedback is above setpoint and the cooling coil control valve is fully open (the most chilled water available is being supplied to the coil), the system identifies a fault. This type of tool saves time in the investigation of performance faults - the FDD tool tells you specifically where to look. FDD tools also typically have alarm capability upon fault detection. The drawbacks of FDD tools are that they can be complex to implement, and false alarms can occur if the system is not set up properly and commissioned.

OCx Step 3: Functional Performance Testing

Functional performance testing is a process by which equipment and systems are tested through all sequences and modes of operation to ensure conformance with operational intent in terms of efficiency and thermal comfort. Testing methods include: trending (data loggers, BAS); control manipulations and response observations (standalone controls, BAS); and the best indicator of unacceptable performance of all - occupant complaints!

When unacceptable performance is identified, the cause of the performance degradation must be determined so that a resolution to the problem can be established.

Using advanced programming tools and techniques, functional performance testing can be automated such that typical commissioning functional performance tests are reproduced both automatically and for many systems at once. Automated functional performance testing should focus on: systems that are likely to fail; systems that consume the most energy; systems critical to facility operation; and equipment that is difficult to access [4].

Automated tests still need to be commissioned so that they are deemed reliable; it is virtually assured that the automated testing will not work as designed unless fully tested [4].

OCx Step 4: Corrective Action

After performance deficiencies are identified during functional performance testing, the next step in the OCx process is taking corrective action [3]. Typical corrective actions can range from minor repair items and additional

operator training to setpoint adjustments or control programming modifications. This point in the OCx process is also a good opportunity to potentially catch items under warranty and avoid repair costs to the building owner.

OCx Step 5: Documentation

The systems manual is updated to document performance goals and operational changes and to establish a single point of reference material for the operations and maintenance staff. An OCx report is produced to document at regular intervals the performance of the facility and success of the OCx program.

OCx Step 6: Facility Personnel Training

Facility personnel training should be updated to ensure operations staff is knowledgeable about building equipment and systems. Training should cover equipment, controls, monitoring software, and all operating scenarios across systems in order to deliver an understanding of how to most efficiently operate the building [8].

OCx Step 7: Ongoing Performance Verification

Performance should be monitored on an ongoing basis to ensure that the building is operating well. When sub-optimal performance is detected, the ongoing commissioning process begins again. In this way, the building is not only achieving the most energy and cost savings possible, but is also adaptable to changing operational needs.

Ongoing Commissioning Results

A 2008 study published by the Texas A&M University's Energy Systems Laboratory titled *The Cost-Effectiveness of Continuous Commissioning Over the Past Ten Years* analyzed the results of ongoing commissioning implementation for over 60 buildings over a ten-year time period [9]. The data set was comprised of commercial buildings (mostly healthcare, education, and office buildings), 90% of which were located in Texas. The purpose of the study was to calculate energy savings and commissioning costs, and to determine what the relationship between the two is (if any). The table below presents the annual energy cost savings documented in the study.

Annual % Cost Savings by Building Type [9]

Building Type	Number of Type	Average % Savings
Education	10	8.71 %
Health Care	8	14.87 %
Laboratory	3	30.38 %
Office	3	18.66 %
Other	2	8.86 %
Overall	***26***	***14.27 %***

* note: other sites did not have detailed energy cost savings data

The costs of commissioning and the first-year energy cost savings were used to calculate simple payback period for 54 of the buildings in the data set (others had incomplete data). The overall average simple payback period was 1.6 years (the median was 1.26 years).

The following table is a break down of ongoing commissioning interventions by recommended corrective action type across the whole data set.

Ongoing Commissioning Interventions by Recommended Action [9]

Intervention	% of Total
Design Change	1.3 %
Installation Modification	3.4 %
Equipment Retrofit/Replacement	7.0 %
Other - Design, Installation, Retrofit, Replacement	1.5 %
Advanced Reset Implementation	22.0 %
Start/Stop Implementation (Environmentally Determined)	4.1 %
Scheduling Implementation (Occupancy Determined)	6.2 %
Setpoint Modification	8.4 %
Equipment Staging	0.8 %
Sequence of Operations Modification	15.0 %
Loop Tuning	5.3 %
Behaviour Modification/Manual Operational Change	1.4 %
Other - Operations and Control	5.2 %
Calibration	9.1 %
Mechanical Fix	6.9 %
Heat Transfer Maintenance	1.3 %
Filtration Maintenance	1.1 %
Other - Maintenance	0.0 %

Approximately 68% of the interventions that were recommended were operational and control-related measures. From these results and the cost savings results by building type, it appears that the more control operators can have over building equipment and systems, the greater the savings resulting from ongoing commissioning activities. It would follow that residential buildings implementing ongoing commissioning would likely experience lower energy cost savings and higher payback periods.

Ongoing Commissioning in Ontario

Beyond the scope of the study shared in the previous section but of importance to us all are the GHG emissions reductions that would result from the implementation of the ongoing commissioning process. Not only is ongoing commissioning beneficial from financial and maintenance perspectives, it is also environmentally beneficial and an ideal candidate for inclusion in climate change mitigation strategies.

As energy and water consumption reporting policy takes effect in Ontario, beginning in July 2018 with large commercial buildings [10], building owners are incentivized to invest in efficiency and conservation measures in order to avoid negative reputational impacts of poorly performing buildings and accumulating costs of retrofits and large capital projects. Ongoing commissioning is a lower-cost solution to continually optimize performance of the building and systems that already exist. This approach is a great candidate to push the wheel forward in Ontario towards better building performance and lower emissions.

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