

**White Paper:**  
**Commissioning for Great Buildings**



**February, 2005**

## Great Buildings: How Hard Can It Be?

As a building owner or manager, do you ever wonder why it is so hard for your design and construction teams to produce exactly the building you want, so that once they finish, all you need to do is open the door and turn on the lights?

If only buildings were so simple. In reality, today's buildings are incredibly complex. So complex, in fact, we cannot design or operate them without the help of computers. Every architect and design engineer uses computer automated design (CAD) software and most non-residential buildings under construction today will be operated by several computers. They manage every aspect of building operations, from thermostats and lights to security systems and fire alarms.

The use of so much sophisticated technology may give the impression that today's buildings are smarter than their operators. And if buildings worked perfectly, all the time, it would be tempting to believe it. But they don't. Today's buildings are having many operational issues from day one. A 1994 study of 60 commercial buildings found that more than half suffered temperature control problems, 40% had problems with HVAC equipment and one-third had sensors that were not operating properly. And amazingly, 15% of the buildings were actually missing specified equipment.<sup>1</sup>

As one engineer explains, "There is a pervasive absence of quality in the finished product. Owners who think they have already paid for and are getting quality are engaging in denial. In far too many projects, cutting out quality has been the business norm, not the exception."<sup>2</sup>

The consequences? Owners are exasperated and occupants are dissatisfied, budgets are constantly overrun and schedules are frequently severely compressed. For owners, O&M costs are high and, combined with high energy costs, represent a constant cash drain on the bottom line. What can we do to make buildings work better? Unfortunately, there is no one-size-fits-all solution. What's needed is a quality assurance process custom-made for each building and its unique problems. *Commissioning* does just that.

### **Improve the satisfaction of owners and occupants.**

As every manufacturer knows, customer satisfaction is one of the most important measures of a product's success. The same is true for building owners and occupants. When occupants are uncomfortable the results are increased complaints, increased expenses and headaches for the owner. In new buildings, commissioning helps prevent the problems that lead to uncomfortable conditions. Like the auto makers of the past, who used consumers to test and evaluate the performance of new car models, many newly constructed buildings use occupants to detect problems with building systems and even diagnose its malfunctions.

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<sup>1</sup> Mary Ann Piette and Bruce Nordman, "Costs and Benefits of Utility Funded Commissioning of Energy-Efficiency Measures in 16 Buildings," in *ASHRAE Transactions*, Atlanta, GA, Vol. 102, Pt 1. Feb. 1996, LBNL-37823.

<sup>2</sup> Paul C. Tseng, "Building Commissioning: Benefits and Costs," *HPAC* (April, 1998), p. 52.

Unfortunately, commissioning was not performed in one recent project, with the expected result, “The numerous comfort complaints immediately following occupancy were the product of both sub-performing and incomplete systems. Had the majority of the issues driving these complaints been addressed...the occupant complaints...would be greatly reduced.”<sup>3</sup>

In existing buildings, responding to temperature, lighting and moisture intrusion complaints eats away at valuable staff time and often depletes the maintenance budget. In a recent study of a federal building in Atlanta, commissioning reduced tenant comfort complaints by 35%, proving there’s always room for improvement.<sup>4</sup> In addition, chronic comfort problems cause tenant turnover – a costly proposition. One study estimated the cost of losing a tenant in a class-A office space as equivalent to one-year’s rent.<sup>5</sup> Word of mouth is a powerful communication tool, and a building can easily develop a reputation for uncomfortable and unproductive conditions.

Unhealthy buildings are an even greater risk. A recent study reported that 20-30% of commercial buildings suffer from indoor air quality problems.<sup>6</sup> “Sick building syndrome” and the court cases associated with it continue to make headlines across the country. Litigation and damages often run in the millions of dollars, not to mention the intangible costs of a damaged reputation, for both building and owner. Many factors cause poor indoor air quality, including low ventilation rates, improperly maintained HVAC systems and moisture and mold. For schools and hotels, such systematic failures in building performance can be catastrophic to their intended missions of education and hospitality. Tremendous sums and personpower has been expended nationwide in these two building categories alone to redress IAQ problems and remediations.

To protect against the problems and expense of an uncomfortable, or even unsafe, building, many building owners and facility managers are using commissioning as a tool to enhance indoor air quality and produce comfortable temperatures and lighting and control moisture.

In Maryland, Montgomery County Public School District has embarked on an ambitious project to commissioning their new schools. The district is currently undergoing a \$1.2 billion, six-year school construction program. In many new and non-commissioned schools, comfort and IAQ problems persist, often years after occupancy. The district facilities staff is keenly aware of the adverse effects on the students’ learning environment. In fact, it was the persistent complaints about IAQ problems and a poor learning environment, from students, parents and teachers that convinced the district

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<sup>3</sup> Michael P. Della Barba, “The Evolving Commissioning Process: Servicing the Repeat Client,” in *Proceedings of 12<sup>th</sup> National Conference on Building Commissioning*, Portland Energy Conservation, Inc. (PECI), 2004.

<sup>4</sup> John Adams, P.E., “Retro-commissioning GSA’s Atlanta Federal Center,” in *Proceedings of 12<sup>th</sup> National Conference on Building Commissioning*, Portland Energy Conservation, Inc. (PECI), 2004.

<sup>5</sup> *Building Commissioning Guidelines: A source book on building systems performance*. Energy Design Resources (a joint project of Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison), p. 7. Based on a 3,500 square foot space at \$50/square foot and a five-year lease value of \$875,000. Includes rent loss due to vacancy (\$43,750), new tenant improvements (\$87,500) and leasing commission (\$43,750), for a total of \$175,000.

<sup>6</sup> *Ibid.*, p. 5.

administrators to initiate commissioning. In the commissioned school projects, a much higher accountability of contractor quality was readily apparent, deficiencies detected much earlier (before occupancy) and equipment operability greatly enhanced. Steve Reeves, a project manager in charge of the commissioning initiative, has now orchestrated the implementation of commissioning at a dozen new school projects currently underway.

### **Improve communication among team members and prevent unnecessary problems.**

Commissioning promotes greater cooperation among the many professionals involved in a project and provides a platform for cross-checking the performance of a building's equipment and combined systems. Commissioning enhances a project team's understanding of the project goals and helps identify problems early, before they become expensive and time-consuming to fix. The result? Fewer change orders, fewer call-backs, a reduced likelihood of litigation and an all-around better project.<sup>7</sup>

One of commissioning's biggest contributions to a new building project comes in the area of building controls, one of the most difficult systems to integrate in any project. As buildings have grown more complex and project budgets have been squeezed, "controls design has been one of the casualties," a recent report noted.<sup>8</sup> Control systems in modern buildings are highly complex and careful design integration is a must. Designers, attempting to cut costs and reduce their scope, relegate controls design to the controls contractor, who in turn delegates responsibility to the controls field technicians. The result? The controls and the systems don't work as intended and no one understands the details, let alone the logic, of the control sequences.

Commissioning solves this industry-wide problem by requiring a controls integration meeting, ideally held during both the late design and early construction phases, bringing together "all those with a vested interest" in the building's controls. These meetings improve communication between parties, generate new ideas to enhance design and often catch problems that might otherwise have gone unnoticed. Because of the controls integration meeting, the designer understands clearly what the owner needs, the owner understands the reasons behind the controls design, and the commissioning provider is able to facilitate the development of the sequences and intended operation – reducing problems down the road and improving building documentation for the operators.<sup>9</sup>

### **Finish your projects on time and on budget.**

Common wisdom tells us the three elements in the construction project triad (quality, cost and schedule) are so closely related that changes to one result in changes to the others. But do you need to pay more and take longer to produce a higher quality building? Common wisdom may say yes, but wisdom is seldom common. *Commissioning* can improve building quality while reducing costs and helping you meeting aggressive deadlines.

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<sup>7</sup> *Building Commissioning Guidelines: A source book on building systems performance*, p. 5.

<sup>8</sup> Karl Stum, "The Controls Integration Meeting," in *Proceedings of 12<sup>th</sup> National Conference on Building Commissioning*, Portland Energy Conservation, Inc. (PECI), 2004.

<sup>9</sup> *Ibid.*

Almost every construction project manager and most owners too, have experienced the “nightmare” project. Where construction documents were incomplete and required massive change orders. Where the costs of the change orders and other unanticipated problems far exceeded the original budget. Where there were so many delays that the scheduled completion date was not met and the occupants did not move in on time. Where a long “punch list” lingered for months after occupancy and it seemed the project would never be finished. Another common situation, especially in fast-tracked projects, finds the building completed on schedule but with severely compromised quality and coordination. The resulting building offers the new occupants a spanking new façade but a list of internal deficiencies and flaws that may never get corrected.

Change orders and Requests for Information (RFIs) are the greatest thieves of both budget and schedule. A new study documented the construction process at a large high school and found that even a simple RFI could require four staff hours of time to resolve. This project had a total of 92 RFIs, consuming almost 10 weeks of staff time. The figures for change orders are even more dramatic. In this non-commissioned project, there were approximately 90 change orders totaling almost \$95,000, equal to 1% of the construction costs.<sup>10</sup>

### **Reduce non-productive O&M costs and improve your bottom line.**

Most buildings are designed, built and occupied *before* there is a plan in place for their operation and maintenance. Poor operation and maintenance leads to premature equipment failure and higher energy costs. Commissioning verifies that equipment is installed and operating properly, resulting in a longer lifespan, increased operating reliability and fewer repairs. A thorough commissioning process also ensures that building documentation is accurate and complete.

Commissioned buildings are more likely to have properly functioning systems with reliable, well-maintained equipment. Commissioned equipment also uses less energy, requires fewer replacement parts and demands less “crisis maintenance” from onsite staff and expensive outside contractors paid on an emergency/overtime basis. As a result, operating costs for commissioned buildings are reported at 8-20% lower than those of a comparable non-commissioned building.<sup>11</sup>

Without proper documentation and training, operators may be able to keep the building running, but at what cost? Commissioning helps minimize life cycle costs by establishing sound practices, thorough training and solid documentation of building systems. In a recent survey of several hundred building owners and managers who commissioned their buildings, 88% noted its positive effects on reducing operational deficiencies and 81% said it improved the knowledge of the O&M staff.<sup>12</sup> Documentation is even more important when owners rely on contractors for O&M work, and there is no operating staff to serve as a repository of building knowledge.

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<sup>10</sup> Kristin Heinemeier, et al. “Commissioning of New Schools: A State Funded Study of the Costs and Benefits,” in *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*, p. 3-92-93.

<sup>11</sup> “Building Commissioning,” (Washington, D.C.: U.S. General Services Administration), p. 6. Available at [www.betterbricks.org](http://www.betterbricks.org).

<sup>12</sup> Charles Bicknell and Lisa A. Skumatz, “Non-Energy Benefits (NEBs) in the Commercial Sector: Results from Hundreds of Buildings,” in *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*, p. 4-18.

## Reduce energy costs by optimizing system operation.

Energy costs can represent as much as one-third of a building's operating expenses, but they don't need to. There is energy savings potential in almost every building.<sup>13</sup>

Decreasing energy costs by increasing energy efficiency is not only good for the environment, it's good for the building owner. Reduced energy costs increase net operating income (NOI) and have a direct effect on the building's appraised value.<sup>14</sup>

As a recent study found, commissioning significantly reduces energy costs.

Commissioning, the authors conclude, "is one of the most cost-effective and far-reaching means of improving the energy efficiency of buildings."<sup>15</sup> Energy savings vary depending on the building's size, energy intensity and the scope of commissioning activities. In existing buildings, commissioning was found to produce a median savings of 15%.<sup>16</sup>

Another large study found energy savings ranging from \$52,000 to \$168,000 per year in office buildings, and savings in the range of \$220,000 in laboratories.<sup>17</sup>

Energy savings from commissioning continue to save money for years after completion, that's the conclusion of another recent study. The study found that an average of 80% of savings persist for at least three years after the commissioning process is complete.<sup>18</sup>

What's even better, many energy-saving fixes are inexpensive to implement. Funding assistance is also available from utilities, governments and other agencies. Together, incentives for energy and water efficiency total more than \$1 billion each year.<sup>19</sup>

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<sup>13</sup> Evan Mills, et. al. "The Cost-Effectiveness of Commercial-Buildings Commissioning," LBNL – 56637 (December, 2004). Ninety-four percent of the 224 buildings studied did obtain some energy savings from commissioning or retrocommissioning.

<sup>14</sup> Mark Jewell, "Energy Efficiency Boosts Property Values: Seeing the hidden value of energy efficient properties," *Energy User News* (April, 2002), and *Building Commissioning Guidelines: A source book on building systems performance*, p. 8. Exact benefits depend on whether a building is owner-occupied or leased, and the leasing structure.

<sup>15</sup> Mills, et. al. (2004), p. 58.

<sup>16</sup> *Ibid.*, p. 31.

<sup>17</sup> Portland Energy Conservation, Inc. (PECI), "What can commissioning do for your building?" Portland, OR, 1998. This study examined 175 commissioning case studies, including 44 office buildings and nine labs.

<sup>18</sup> N.J. Bourassa, "Evaluation of Retrocommissioning Persistence in Large Commercial Buildings," in *Proceedings of 12<sup>th</sup> National Conference on Building Commissioning*, Portland Energy Conservation, Inc. (PECI), 2004.

<sup>19</sup> Mark Jewell, "Understanding the Value of Commissioning in Income-Producing Office Buildings," in *Proceedings of 12<sup>th</sup> National Conference on Building Commissioning*, Portland Energy Conservation, Inc. (PECI), 2004.

## **Commissioning for Great Buildings**

### **Commissioning is a *systematic* process.**

It integrates and enhances the traditionally separate functions of design peer review, equipment operational documentation and facility staff training, as well as functional testing and performance verification.

### **Commissioning is a *quality assurance* process.**

It spans from pre-design to construction and start-up and increases the likelihood that a new building will meet the owner's expectations. Commissioning enables a building to begin its life cycle at optimal productivity and assists in maintaining this high level of performance. Commissioning brings back the missing ingredient necessary for all great buildings: not a fancy façade and curb appeal, but an infusion of quality.