High Performance Building Technician Training and Certification

Presented to

NSF BEST Center
Building Efficiency for a Sustainable Tomorrow

Rev 4 2015-01-05

Prepared by Building Intelligence Group LLC:
Paul Ehrlich, PE
Mark Fenimore
(651) 204-0105
info@buildingintelligencegroup.com
www.buildingintelligencegroup.com

Special thanks to Peter Crabtree, Dean of Career and Technical Education at Laney College, for his guidance and assistance in the development of this report.

Table of Contents

1 Executive Summary

The commercial and public buildings that Americans rely on daily for work have a well-defined impact on our economy as well as the environment. Commercial buildings alone are responsible for almost 20 percent of all energy usage and carbon dioxide (CO_2) emissions in the United States. Moreover, because of the critical need to preserve energy consumption for transportation and industry in order to support the economy, net reduction of energy consumption and CO_2 production in buildings is all the more urgent. In spite of their importance though, insufficient attention is paid to the proper training and professional development of the technicians, operators, and facility managers responsible for the effective and efficient operation of commercial buildings.

Today's typical commercial facility has a diverse staff of building operators and engineers, and the background, experience, and training of building operations personnel varies as much as the buildings they work in. For noticeable improvement in energy consumption to occur across the vast portfolio of U.S. facilities that they manage, a different and more proactive approach is needed to prepare today's building technicians. While core advancements in primary HVAC equipment technology have been relatively slow compared to other technical fields, developments in modern digital monitoring, control, and communication systems have facilitated innovative techniques and strategies that can provide energy saving opportunities, improvements to indoor environmental quality (IEQ), and other benefits.

Recognizing the growing importance of energy conservation and the increasingly stringent local ordinances, state codes, and national standards that will continue to advance in the commercial building sector over the next 10-15 years, it is clear that the need for high performance building (HPB) technicians with analytical, whole-systems skill sets will be essential in order to meet future policy guidelines regarding energy, emissions, IEQ, and sustainability. Because of their unique position and capacity in providing technician education and training, community colleges should expect to play a key role in educating HBP technicians in the future.

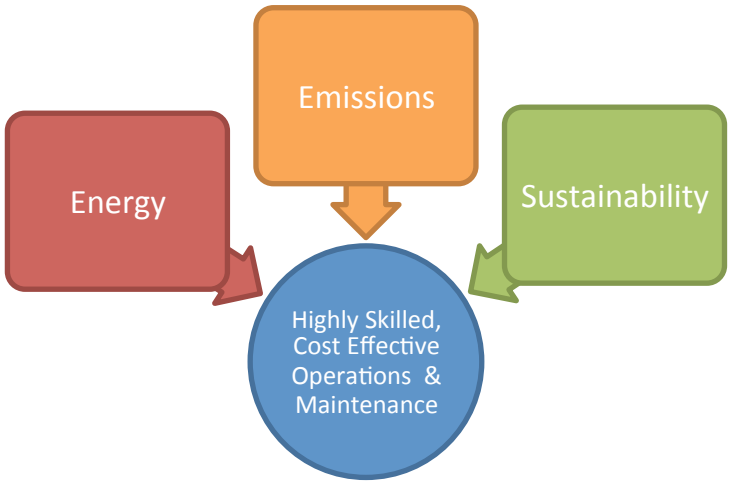

Figure 1: Issues driving demand for HPB technicians

This report attempts to identify the key elements for HPB training and certification to meet the growing need for skilled technicians capable of operating and maintaining high performance buildings now and in the future. This analysis specifically addresses the following:

1) Traditional preparation and role of building technicians
2) Changes expected in the commercial building environment
3) The need for high performance building (HPB) technicians
4) Emerging skill sets required for HPB technicians
5) HPB technician certification recommendations

2 Traditional Preparation and Role of Building Technicians

2.1 Skills and Training

When attempting to identify how to effectively educate and train future HPB technicians and forecast the types of skills sets that will be required to operate high performance buildings in the years ahead, it is important to identify how workers have typically entered the field in the past so that entry skills can be improved or changed to help adapt to the coming changes in the industry. Historically, building technicians have come into the field from a variety of backgrounds and many have not had much formal training. The skills of many incumbents in the field have been learned through "on-the-job training" (OJT) provided by traditional apprenticeship programs or military experience, or through even less formal training in which senior technicians or engineers have showed new entrants how to fix and maintain equipment, operate specific types of machinery, or manage various building control systems.

The mix of skill sets encompassed by today's typical technicians as they relate to the operation of a commercial facility include the following:

- Primary Skill Sets:
  - Mechanical
  - Electrical
  - Plumbing
  - Carpentry

- Secondary Skill Sets:
  - Control Systems
  - Security Systems
  - Fire Safety System Upkeep
  - Elevator Equipment Maintenance
  - Parking Lot Management
  - Wildlife Control

While these primary and secondary skill sets are often essential in order to maintain equipment and operate a building to provide adequate safety and comfort for its occupants, the abilities most technicians acquire through minimal formal training courses and OJT seldom address proactive measures for energy management and improved IEQ. Instead, building operations groups tend to be focused on satisfying tenants' immediate demands and making what is in place work reliably, a "fix what is there" mentality. This tendency results primarily from the fact that technicians often find themselves serving as the de-facto interface between owners, property managers, occupants, and tenants. Balancing the conflicting needs for energy efficiency and comfort consequently becomes difficult to achieve, and energy conservation, if it is on the technician's radar at all, is sacrificed for the sake of pacifying the building's occupants. Moreover, the pervasive culture of building operations, often driven by budget and personnel constraints, tends to be that of "fighting fires", which is antithetical to a proactive operational culture of predictive maintenance, system optimization, and energy conservation.

The goal for the education of an HPB technician should go well beyond component-level repairs. The focus should instead be on developing skill sets that allow technicians to take a broadly analytical approach to the management and control of building systems. This will require proper education and training for technicians concurrent with a new awareness and behavioral change from all levels of property ownership and management, with an understanding that reaching future goals for energy efficiency and occupant productivity will require a greater investment in both building operators and building technology.

2.2 Job Roles and Standards

Throughout the field of building operations and facility management, there exists a broad range of roles, job titles and responsibilities. This variety of professions is a product of the way in which technicians have been educated and trained, and each facility has its own unique blend of experience and expertise on staff. These positions can include:

- Custodian
- Building Technician
- Maintenance Person
- Building Supervisor
- Building Engineer
- Chief Engineer
- Building Operator
- Facilities Manager/Director
- Energy Manager (emerging occupation)

The industry currently has limited formal definitions for many of these roles, and they often vary from site to site. In some areas of the country, union rules can impact how work can be done and by whom. Codes, standards, climatic conditions and systems also vary from region to region, which can also influence what types of building technicians are employed and what skill sets they must possess. Developing a clear definition of what an HBP technician must exemplify will require a much clearer understanding of necessary skill sets, as well as a more specific set of educational and training requirements.

3 Expected Changes

To help distinguish what the HPB technicians of today's most progressive facilities should embody from a technical standpoint, it is paramount that the trends in the commercial and industrial buildings industry be understood and anticipated. Currently, the industry is in the midst of an evolution towards smarter and more efficient buildings, primarily due to the growing importance of resource conservation as well as societal and political pressures surrounding the threat of climate change and its effects on the environment and future economic and security prospects.

Programs such as LEED® from the U.S. Green Building Council and ENERGY STAR from the U.S. EPA are increasingly used for both new and existing buildings, and U.S. government buildings are under executive and legislative mandates to dramatically improve efficiency and reduce greenhouse gas (GHG) emissions. Private industry has followed suit, including corporate sustainability goals for both owned and leased space. This is all part of a global effort to reduce CO_2 emissions, of which buildings are a major contributor. Institutions such as public universities are also discovering that aggressive energy

conservation efforts can result in big savings on utility bills at the same time as meeting sustainability goals.

While most of the emphasis on sustainable and high performance buildings has been in new construction, existing buildings have the greatest environmental impact. Older buildings were often built using less stringent standards and are being operated at sub-par performance levels. Building operations have a major impact on the delivery of efficiency and sustainability goals, and to achieve future requisite levels of building efficiency, a transition will be required in how today's buildings are typically operated. The current model based around occupant appeasement and reactionary maintenance measures will have to be carefully shifted to provide a more proactive approach towards efficiency while still maintaining required levels of safety and comfort.

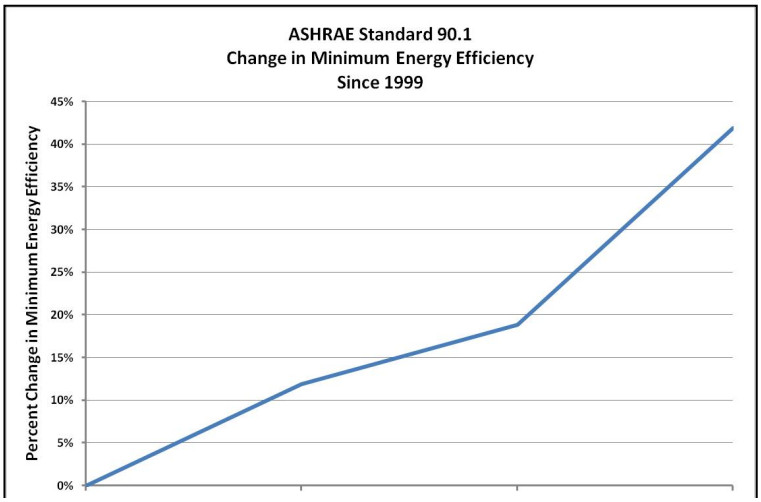

Figure 2: ASHRAE 90.1 minimum energy efficiency

Several other options for addressing the increasing need for HPB technicians and the capacity they represent may include a broader use of automation, potentially with a portion of operations functions being outsourced virtually. The use of improved diagnostic software for facility operations could also be integrated with other support groups such as information technology (IT), allowing for streamlined, preemptive analyses and optimization of facility performance across an entire portfolio of ownership. This would allow for a team focus as well, possibly with increasing reliance on specialized experts in various aspects of building operations that would provide greater levels of assessment and improvement measures. Many of these possibilities would be reliant upon data gathered from facility building automation systems (BAS). New energy information systems (EIS) allow for the analysis of large data sets and the setup of custom control and alarming functions, which could provide simplified evaluations for building technicians and their teams. If some of these promising technical innovations do occur, the result may well be a decline in the demand for traditional lower skilled technicians and an even greater demand for HPB technicians who can interpret data, draw inferences, and respond accordingly.

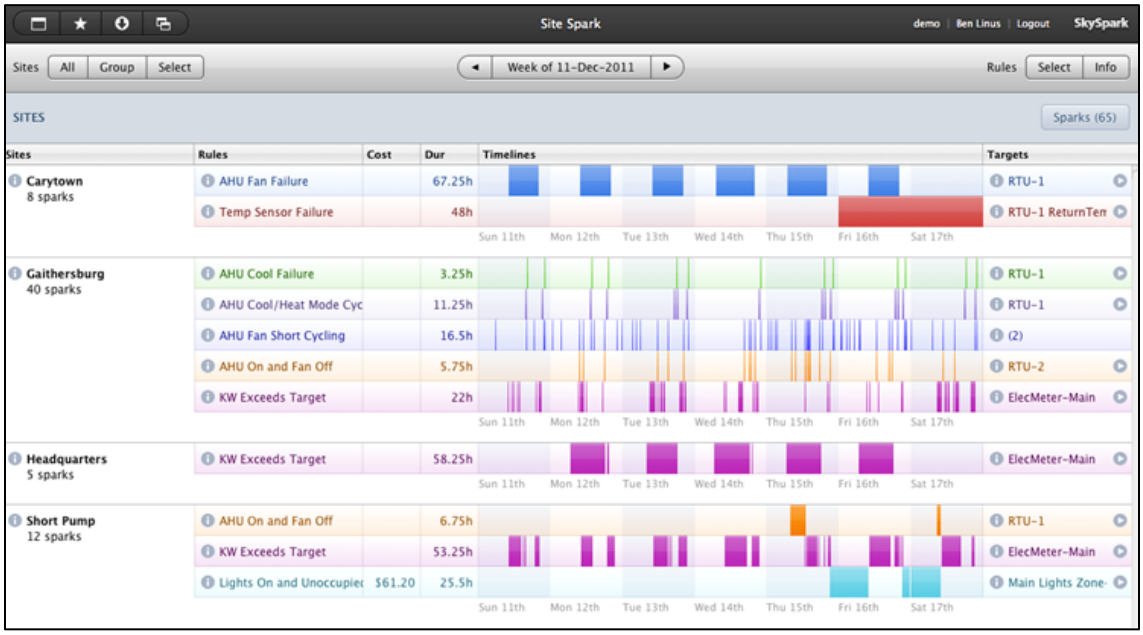

Figure 3: Energy information system example

4 The Need for HPB Technicians

With the changes that are advancing in the commercial building operations industry, the call for HPB technicians cannot be ignored. It is highly likely that local and state policies regarding efficiency, emissions, IEQ, and sustainability will follow past trends and continue to tighten in coming years. This will drastically increase the demand for better skilled technicians who have been educated and trained to operate high performance buildings, and it places more importance on preparing this next generation of skilled HPB technicians now so that they are prepared for what is already in progress.

To meet this looming need with an appropriate response, a clearly-defined curriculum, training and certification for use by community colleges should be developed to ensure that future building technicians have the required analytical skills to meet the challenges associated with reducing energy consumption in the myriad of facilities across the country. The typical OJT that most up and coming building operators are currently receiving from their mentors and supervisors often does not allow for the incorporation of new technologies and development of cognitive skills that may be key to achieving such optimistic goals for efficiency and improved IEQ. Experience gained on the job should be supplemented with readily available, effective instruction designed by educators with input from industry experts who are aware of the technologies and strategies that will help meet future goals for efficiency.

5 Emerging Required Skill Sets

While much of the world's technology has advanced rapidly over the past few decades, HVAC has seen a much more limited progression. Equipment used for primary heating and cooling, control systems for equipment, and building lighting systems have all been improved, but widespread adoption of each of these new technologies has been impeded by difficulties and constraints. For many years, pneumatic controls have been replaced with digital control systems, yet these BAS systems often overlay pneumatic sub-systems that are still found in a large percentage of commercial buildings. Similarly, chillers and

boilers that have far exceeded their estimated life cycles, as well as lighting that has not been updated to current standards, continue to operate alongside newer equipment and lighting systems that have been layered into overall building systems.

In relation to these changes over the years, building operators have had to learn new skill sets in order to operate and maintain various generations of equipment. This state of affairs will likely continue as newer technology is developed and installed because the prohibitive costs associated with large-scale replacement of building systems will ensure that multiple generations of equipment remain in place and require maintenance and inter-operability over decades of service. This system layering will require future HPB technicians not only to have the cognitive and adaptive expertise to master future technologies, but they will need to have the skills and training to operate and adapt older equipment to the evolving standards of the future.

Technologies and systems anticipated to be required in future high performance buildings include the following:

- **Building envelope:** Active facades and advanced thermal insulation
- **HVAC:** Radiant heating and cooling panels, dedicated outdoor air systems, demand-controlled ventilation and natural ventilation
- **Lighting:** Advanced lighting, lighting controls and automated shading
- **Controls, automation and integration:** Open standard protocols, middleware and enterprise systems, networks and connectivity, wireless controls and metering
- **On-site generation and storage:** Renewable energy, on-site power generation, thermal storage and cogeneration
- **Information management systems:** Computer aided facility management systems (CAFM) and computerized maintenance management systems (CMMS), energy management dashboards, and middleware and enterprise systems
- **Building information modeling (BIM):** BIM can help provide dynamic building information and support the analysis of building operation

In addition to understanding both past and future technologies and systems that will be found throughout high performance buildings, the following core knowledge, skills and abilities are needed:

- **Development of new tools and processes:** Improved tools and processes for building operations need to be more broadly deployed and effectively used. These include tools for evaluating and measuring building performance, scheduling maintenance, analyzing systems, and financial calculations for various return on investment (ROI) metrics. While most of these tools are commercially available today, they are rarely applied uniformly within facilities or properly integrated into well-documented processes.
- **Building performance:** Building performance must be clearly and practically defined by identifying best-in-class building systems and management processes. To determine what is possible and define strategies to move towards net-zero building design and operation, best-in-class examples from buildings in the United States should be at least benchmarked and compared to best-in-class examples from buildings around the world.
- **Ongoing performance measurement:** Finally, a system for ongoing performance measurement and management is needed. Rigorously defined performance criteria should include energy efficiency, carbon footprint, IEQ, uptime, and tenant satisfaction.

6 HPB Technician Certification Recommendations

Certification for HPB technicians should encompass the major domains of knowledge and skill that will be required to operate future buildings efficiently, without sacrificing standards for comfort and safety. HPB technicians will require at least two years of education in community college to receive hands-on training and to build core knowledge of the following:

- Thermodynamic principles including heat transfer, psychrometry and properties of fluids and gases
- Greenhouse gas production and climate change
- Engineering basics (math, physics, chemistry, unit conversions)
- Refrigeration cycle
- Electricity and electronics
- Properties of light
- Basic statistics and data analysis
- Strong computer literacy including Excel and basic programming principles
- Problem solving strategies using evidence and hypothesis
- Operating principles of complex, interactive systems
- Human comfort factors and indoor environmental quality
- The building life cycle
- On-site generation and renewable energy systems
- Basic financial principles including ROI, cost recovery, and opportunity cost
- Principles of energy efficiency
- Health and safety (OSHA, fire safety, security, personal safety, personal safety, emergency response)
- Business basics (economics, budgeting, teamwork)

HPB technicians should also be trained to understand, maintain, operate, and optimize the following components and systems as they relate to preventative maintenance, basic troubleshooting, and energy management:

- Chiller Plants
- Boiler Plants
- All categories of Air-Handling Equipment
- Building Automation Systems
- Control Programming and Strategies
- Analytical Tools
- Lighting

As with any profession, proper education, training, and hands-on laboratory experience with a certification exam will be necessary for the position and title to be taken seriously. HPB technicians should represent the future of building operations, and subject matter should reflect this accordingly. New ideas and concepts, in addition to best practices currently in use throughout the industry, should be presented as the standard for energy efficiency moving forward. While basic understanding of past equipment and technology needs to be addressed, this curriculum should be an opportunity for forward-thinking and the development of the future generation of building operators that will have to surpass what is acceptable today in terms of operational efficiency.