The Dilemma of Aging Facilities: Strategies for Future-Proofing a Higher Education Campus

by Tara Canfield and Craig Graff

Executive summary

A top priority for higher education institutions is to provide a competitive learning environment for their students. In order to succeed, they must address outdated, aging campus facilities. In these older buildings maintenance and operations costs are high, space utilization is inefficient and poorly managed, and current technology is lacking. This white paper explores four strategies for converting campus facilities into a network of smart buildings that address the needs of current and future students.

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Introduction

The connectivity, reliability, sustainability, and efficiency of classrooms, dormitories, recreation, dining, and athletic facilities are critical in today's competitive higher education environment. Student and faculty recruitment, national rankings and the overall welfare of the campus population are all impacted by the condition and usability of the school's facilities.

The importance of an institution's buildings was emphasized in a 2014 APPA report, *Leveraging Facilities for Institutional Success*, which summarized findings from the organization's yearly symposium for thought leaders in higher education. Attendees at the symposium agreed to endorse the following position statement:

> *"Higher education facilities can help colleges and universities achieve their goals and they can contribute in meaningful, measurable ways to the mission of the institutions. Successful campuses will be those that leverage their facilities assets and operations to maximize their potential*."

"Schools must future-proof their campuses so they can continue to leverage their facilities, not only in today's competitive environment, but also in the years to come."

To achieve academic and financial goals, schools must future-proof their campuses. Through system-managed space utilization, advanced energy management systems, and up-to date IT and communications technology, financial performance and operational efficiency of buildings can improve.

However, such upgrades can be costly. A significant number of aging buildings (built 50 or more years ago) are difficult to "future-proof." The core systems that run these buildings – such as HVAC, lighting, electrical, and IT and communications – are more likely to need repair or replacement. Because of their age, they often use excessive energy, which adds to ongoing operational costs. In addition, older campus buildings are often plagued with misused or unused space. As the needs of the schools change over time, and as student requirements evolve, the facility infrastructure needs to adapt.

Although many schools utilize energy management systems (like a building energy management system or BEMS), these, too, have aged and are obsolete and not performing well. In most cases, newer systems have been added in over time without consideration for integration of the older systems.

The penalties for a lack of investment in this area include less federal and state funding, reduced tuition fees, and rising energy costs.

This paper explores how school administrators can future-proof their campuses through better space allocation, proactive maintenance, and the modernization of existing facilities. The paper also examines how modern energy management and building management systems can help optimize campus facility performance.

The challenges of an aging campus

Almost every higher education institution in the United States is faced with the dilemma of aging facilities. According to the Sightlines report, *State of Facilities in Higher Education: 2014 Benchmarks, Best Practices, and Trends*, 51% of all buildings on American college campuses were built between 1951 and 1990.[1] These buildings are either nearing or already have reached critical lifecycle thresholds and are in need of renewal or replacement. Much of this is due to the fact that 40% of these buildings were constructed between 1950 and 1975, an era when construction quality was sacrificed for speed. In the construction period that followed (1975-1990), low-quality building products were used, which also contributes to the need for repair or renovation (see **Figure 1**).

[1] http://www.sightlines.com/sightlines-report-finds-that-51-of-buildings-on-college-campuses-now-approaching-critical-lifecycle-thresholds/

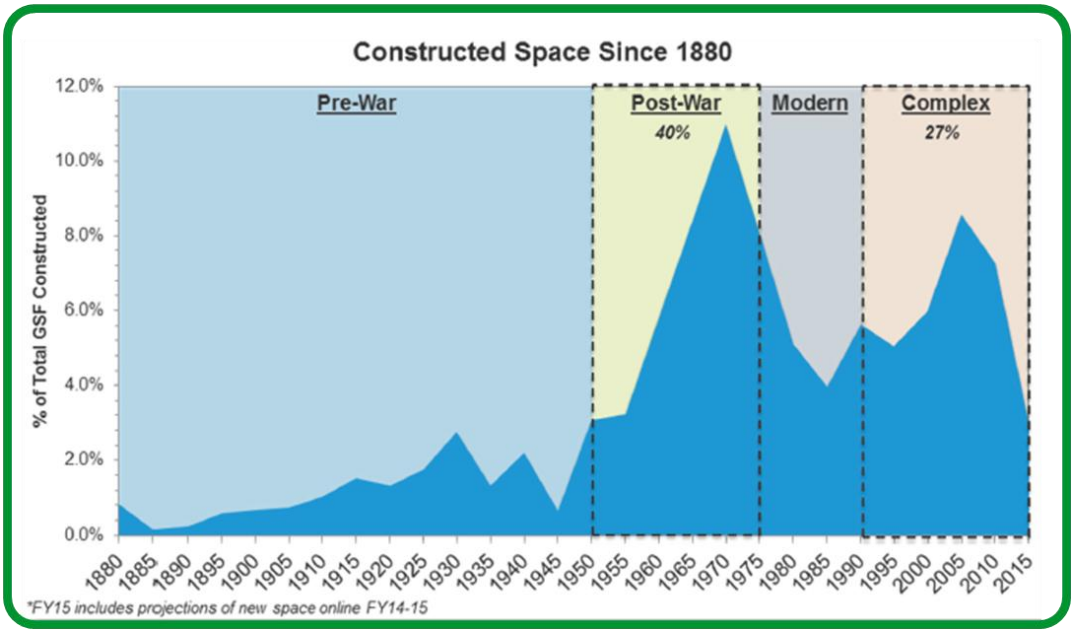

Figure 1
Source: Sightlines: *State of Facilities in Higher Education 2014 Benchmarks, Best Practices & Trends, page 5*

As operating costs rise, budgets remain flat, and maintenance backlogs grow, the work and cost involved in upgrading the older buildings also rise. According to the aforementioned APPA report, work orders in buildings between 25 and 50 years old average $2.35 per square foot compared to $1.40 for buildings under 10 years old. The report also notes that older buildings have higher maintenance backlog costs. For buildings between 25 to 50 years old, for instance, the cost is $110 per gross square foot of building. For buildings 50 years old or older, the cost is $160, while maintenance backlog costs for buildings 10 years old or less are, on average, only $20 per gross square foot.

Unused space in facilities

Sightines uses the term “functional obsolescence,” to describe a situation where room capacity exceeds enrollment numbers.

Facilities are an institution’s most valuable asset, yet it is not uncommon for a school to have little to no awareness of what buildings are being used and when. In fact, it’s not unusual for classrooms to be unoccupied 60% of the time.[2]

For most institutions, many buildings are in full use during prime hours of operation (weekdays during the typical school-year calendar). But beyond those times, and during campus breaks, many institutions still keep all of their buildings well lit, heated, or cooled when not in use – all of which is a costly hit to a school’s operational budget.

Inefficient energy usage

Higher education institutions in the U.S. spend over $14 billion on energy every year. In 2013, the national average expenditure for facilities operations, including maintenance, custodial, grounds, planned maintenance, and administration, was $4.90 per square foot.[3]

It’s estimated that these institutions spend an average of $1.95 per square foot on electricity and $.15 on natural gas annually (see **Figure 2**). This accounts for over 40% of the operations costs mentioned above.

[2] http://www.sightlines.com/what-we-do/space-management/

[3] http://www.sightlines.com/insight/state-of-facilities-2014

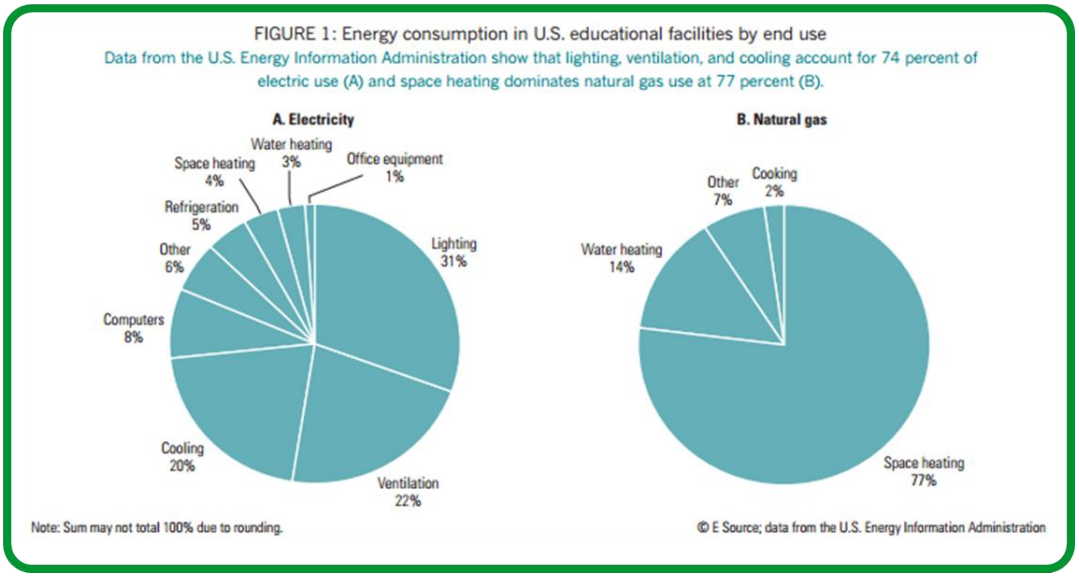

Figure 2
Source: EnergyRight solutions, *Managing Energy Costs in Colleges and Universities,* 2010

A typical 50,000 square-foot higher education building uses more than $100,000 worth of energy each year, and that lighting, ventilation, and cooling account for 74% of all electrical use.[4]

Outdated IT and communications infrastructures

When many higher education facilities were built, the Internet was just a concept. But today's students are part of a highly connected society and they expect the infrastructure at colleges and universities to be technologically advanced.

"Today's buildings generate huge volumes of data on energy usage, but few institutions have the right systems to take full advantage of it."

The reality is that existing classrooms and lecture halls were not designed with laptops and mobile devices in mind – nor were administrative buildings. A simple example is electrical outlets – with every student carrying a mobile device, there is a greater need for more outlets than when the schools were designed 40 or 50 years ago.

Outmoded energy management solutions

Today's buildings generate huge volumes of data on energy usage, but few institutions have the ability to interpret and apply that data.

Older building management systems are rarely upgraded, and have fallen behind the latest technology, limiting the amount of energy and building data schools can use for efficient maintenance and management.

Turning an aging campus into a smart one

In order to address all of these cost and obsolescence issues, a smart campus concept will need to incorporate functional infrastructure systems with automated processes, streamlined operations, and data-driven campus facilities management. The smart campus has mechanical, electrical, information and communications technology, and security systems that are connected and integrated.

A single, intelligent control system communicating through an IP backbone and built upon an architecture of open standards will enable energy and operational cost savings. Such a platform will also accommodate future technologies as they emerge without the need for major reconfiguration.

[4] Managing Energy Costs in Colleges and Universities, E Source, 2010

While new construction is sometimes the only option for older buildings, other alternatives and strategies exist that will boost the operational efficiency of facilities. Below are four to consider.

Strategy #1: Predictive and preventative maintenance and system modernization

Predictive and preventative maintenance is one of the key ways to future-proof campuses. It not only saves costs, but it also extends the life of a building and its systems through the optimization of facility performance.

In fact, surveys show that facilities can achieve benefits such as:

- A 10x return on investment
- 25-35% reduction in maintenance costs
- 70-75% fewer breakdowns
- 35-45% reduction in downtime
- 20-25% increase in production

Diagnostic and preventative tools exist that can help identify repairs and maintenance requirements before issues reach a critical mass. Waiting too long jeopardizes a campus' capital investment in its facilities as buildings deteriorate and require more costly maintenance.

"Studies show students' performance increased by an average of 15% and up to 30% with improvements such as better indoor climate control."

However, given the age of some campuses, modernization may be required. Participating in a retro-commissioning process can help schools examine the systems and controls in a building to evaluate their efficiency, functionality, and alignment with current energy standards.

The benefits of retrofitting campus mechanical systems are broad and deep. Not only can this process improve facility efficiency and increase occupant comfort, but it can also help decrease operating costs, improve productivity of a campus population, and contribute to a school's sustainability programs.

In fact, studies show students' performance increased by an average of 15% and up to 30% with improvements such as better indoor climate control. As schools invest more in preventative maintenance and retro-commissioning, energy costs will be reduced automatically.

Schools do need to be realistic, however. If a building is too old to accommodate today's education and technology needs, or the cost of maintenance outpaces the price of a new facility, new construction may be warranted.

Strategy #2: More efficient space utilization

Many schools have recognized that better space allocation can lower operating costs and improve the overall function of a campus.

In the *2012 Inside Higher Ed Survey of College & University Business Officers* report, participants identified better management of campus space as part of their top strategies for cost-cutting in the next couple of years. In fact, nearly half of the participants (over 44%) cited the effective use of facilities as important, underscoring the need for better space management.[5]

As participants at the 2013 APPA Thought Leaders symposium noted, colleges and universities need to change their entire thinking around space and begin valuing it as an institutional asset. These school administrators identified several supporting best practices that included:

[5] 2013 APPA Thought Leaders: The Rising Cost of Education

- Establishing metrics to better measure how space is used
- Developing policies for clear, effective standards on space
- Establishing a campuswide system for allocating and managing space
- Encouraging desired space management behaviors with incentives or costs
- Designing spaces that are easy to manage

Simply put, institutions need to take a comprehensive look at their space allocation to gain a better understanding of the facility resources they have. A full inventory of resources will help them determine when rooms and buildings are currently used, and the costs associated with each.

Technology advancements make it easier for universities to manage the space on their campus. For example, smart room controllers are replacing standard thermostats and can easily be connected wirelessly to occupancy and door sensors to track space usage. The data from these controllers can also be used in a building energy management system so that historical analysis of the data can help administrators make data-driven decisions on how to use space appropriately.

Other analytics tools, such as a centralized scheduling process, can also be added into these systems to help optimize room usage, so that the right space is used for the right purpose at the right time. Academic calendars can also be combined for more effective space usage.

Strategy #3: Connected IT and communication systems

A survey of facilities managers in higher education discovered that 61% of the respondents felt they needed to update classroom space to meeting changing needs.[6]

This is especially true in aging campuses that need to be rewired for today's educational and administrative needs.

Technologically equipped institutions use innovative interactive solutions for collaboration, new teaching and learning modalities, white boarding, and video conferencing, which extends learning beyond the walls of a typical classroom.

"Institutions can save as much as 30% with effective energy management measurements."

In addition, an innovative technology infrastructure will provide greater support for administrative and business processes, with integrated systems and advanced analytics for everything from building and energy management to student lifecycle management.

The automation of processes, streamlined operations, and intelligent use of data will be a major step toward building a smart campus.

Strategy #4: Better energy management

Institutions can save as much as 30% with effective energy management measurements. In fact, the U.S. Department of Energy (DOE) publishes a rule of thumb that operation and maintenance programs targeting energy efficiency can save 5-20% on energy bills with little capital investment at all.[7]

Many schools now have aggressive sustainability programs that call for zero carbon use. To achieve results like this requires the use of a sophisticated energy management system that tracks usage throughout a campus and aligns room settings with space occupancy.

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[6] Ibid., 5.

[7] http://www.nrel.gov/tech_deployment/climate_neutral/energy_efficient_building_management.html

An added benefit to this is that sustainability initiatives appeal to incoming students. A study shows that 42% of four-year colleges in the United States have found environmental or sustainability programs help recruit students.

Another key part of energy management is an advanced, innovative building energy management system (BEMS). In fact, this is one of the most critical future-proofing tools an institution can employ – as it helps institutions achieve many of the aforementioned strategies.

For instance, a BEMS solution helps reduce risk on an institution's campus by identifying where critical maintenance and repair is needed and where it's wise to invest in retrofitting versus new construction.

A BEMS can collect tremendous amounts of data from across a campus as it monitors, measures, and continuously optimizes energy consumption. This helps to isolate and alleviate inefficiencies like unused space, or aging heating, cooling, and air systems, reducing energy costs and operations budgets.

A BEMS that utilizes open protocols is adaptable to future technological upgrades. Existing systems can be updated quickly to accommodate changing technology and future advancements, ensuring that aging buildings are equipped with the latest and most powerful innovations throughout their entire lifecycle.

What does a connected, smart campus look like?

As schools future-proof their facilities, they have unprecedented opportunities to add intelligent innovation that will build a smart foundation and integrated campus infrastructure for years to come. These kinds of steps will more fully ensure an institution's facilities are truly aligned with its goals and policies on space management and capital allocation.

Figure 3 illustrates what a smart, integrated infrastructure looks like. This can apply to a single building or across the entire campus.

Figure 3
A building energy management solution is critical to future-proofing a school campus

Where to start

Creating a smart campus requires buy-in from administrators, and a strong commitment from all parties involved, including faculty and students.

Here are a few recommended steps to help institutions embark on the journey of creating a smart, connected, and efficient campus:

Build a team of stakeholders and identify needs. Make a list of influencers, decision-makers, and system users from building facilities, sustainability, IT, school administration, and students, as well as architects, designers, and engineers. Identify needs they may have related to campus facilities and invite them to participate when the appropriate aspect of the process requires their expertise and support.

Understand the campus' facilities and respective needs. Perform a complete evaluation of the institution's assets and how they are used. Correlate this with the costs of operation and maintenance to determine the most pressing, at-risk facilities and systems. Utilize industry benchmarking tools to accelerate this process.

Collect and use data wisely. Data and analytics are key to making smart decisions. Data can be collected on space utilization, energy management, building management, technology, and more. It can then be analyzed so administrators can make informed, data-driven decisions.

Develop a 5-10 year plan of action. There will be critical actions that must be addressed immediately, but some could be scheduled proactively over the course of a multiyear period. Others could be moved farther out as part of a preventive, rather than a reactive, action plan.

Determine priorities. Each institution will have its own unique building facility requirements. Delineate the objectives, priorities, and other pertinent criteria for a future-proofing plan that is appropriate.

Set capital improvement priorities. As part of a longer-term plan, prioritize where CapEx and OpEx budget funds will be most effective.

Conduct educational workshops. Make campus populations – and all the stakeholders – aware of the future-proofing efforts and how they can contribute and support them.

Evaluate and invite experts that can help. Experienced vendors can help institutions monitor, measure, and manage systems across an entire campus. These vendors provide integrated facilities management and control, with an integrated infrastructure that connects mechanical, electrical, IT and communications technology, and security systems.

Create a request for proposal. As potential partners are identified, create a short list of qualifying vendors and develop a request for proposal.

Choose the best solution. In reviewing requests for proposals, it will become evident which solution providers can best meet the requirements of the recommended strategies delineated here.

Use cases

Schools around the country are undertaking massive efforts to make their facilities smarter. Here are a few examples:

The University of North Texas gained a 31% reduction in energy costs, equal to $14 million in savings, over the course of two energy savings performance contracts. As one of Texas' largest universities, the 105-year-old university has 54 buildings in its 12 colleges and schools. To achieve its goal of a "climate neutral" campus, the school underwent a series of renovations and energy upgrades, which included retrofits to the learning environment and

direct digital controls for improved comfort. The school also put in variable frequency drives for better air flows, improved lighting systems, and other equipment and systems upgrades.

The Virginia Community College System saved up to $2 million annually and reduced CO_2 emissions by over 12,000 tons with a four-year performance contract covering 315 buildings on 40 campuses. The school system had buildings that were built in the 1960s and 1970s and were not performing optimally. Through renovations, the school implemented sustainable designs that maximized energy efficiency and generated utility savings. This included redesigned and replaced HVAC systems, as well as direct digital controls, more efficient lighting, thermal water storage systems, efficient plumbing fixtures, updated building envelopes, and repaired roofs.

Biola University, a private institution in Southern California, has optimized its energy efficiency through a cost-effective solution that reduced energy waste and operating costs. After researching its energy usage, the university determined that it could save significantly by controlling the air conditioning of dorm rooms that were unoccupied nearly 30% of the time. This move could potentially save 100 tons of air conditioning in peak hours, with savings of more than $11,500 annually. To achieve this goal, the university opted for a $200,000 project for room controller with PIR motion sensor functionality in lieu of a new $1.2 million chiller.

Bond University, situated on the Gold Coast of Australia, uses a self-guided interactive energy display to showcase its world-class Mirvac School of Sustainable Development. This facility, which has a mission to advance the teaching of sustainability principles and practices, uses a modern building management system that collects data and shares it in its Living Lab interactive display. Among its achievements are a 75% reduction in energy usage through natural lighting and mixed mode ventilation and an 82% reduction in its carbon footprint. It also uses renewable energy produced by solar, wind, and regenerative drive lift. It is the first educational institution to earn 6 Star Design rating by the Green Building Council of Australia, and it's received an International Sustainability Award as well.

Bryant University in Smithfield, Rhode Island has seen a 15% reduction in energy consumption in its data center, with similar savings expected campuswide across 50 buildings on 428 acres. This initiative, which started with the creation of an energy-efficient data center, extended into collaboration between the university's IT and facilities team to deliver greater insight and control of energy consumption across the campus. The university consolidated its distributed data storage space from 1,200 square feet to 500 square feet, achieving a monthly decrease in energy consumption of about 20% in the new data center. To extend this success, the university brought together separate IT and facilities units and began to replicate this initiative across the entire campus. The university converted campus structures to smart buildings and installed instrumentation that enabled facilities to monitor and collect data to establish a baseline for energy consumption across campus.

Kingston University in London has a goal to reduce its carbon emissions by 35% by 2020. It embarked on an energy savings program that has already saved the university over $125,000 and achieved a carbon reduction of 444 tons. These savings were realized through improvements to its HVAC system, namely the implementation of variable speed drives, which helped the university to achieve a 40% energy saving in motor currents.

Conclusion

Higher education campuses have a critical need to develop an innovative infrastructure to ensure that all facilities meet the needs of students, faculty, and administrators both today and in the future.

Such investments will create cost efficiencies and increase the quality of life for users of campus facilities. A “smart” campus will help recruit students and faculty, and improve a school’s national rankings. In addition, the value of the education will increase, as will the overall welfare of all constituents.

Other resources that may be of value in this journey toward future-proofing campus facilities:

- Create a sustainable, high-performance university campus. http://se-enable.com/wp-content/uploads/Create-a-sustainable-high-performance-university-campus.pdf
- Predictive Maintenance Strategy for Building Operations: A Better Approach: http://www.schneider-electric.us/documents/buildings/wp-predictive-maintenance.pdf

About the authors

Tara Canfield leads Schneider Electric’s efforts in the education segment. As the Education Segment Director, she is focused on uncovering solutions that address the most critical needs for educational facilities, addressing topics such as reducing energy costs, increasing security, and planning efficient buildings. Tara started her career with Schneider Electric in 1995 and has held numerous positions. These include offer management, technical, marketing, and business development roles, where she had a strong focus on the power and building management needs within the construction process. She holds a B.S. in chemical engineering from the University of Arkansas, as well as a Master of Business Administration from Pennsylvania State University.

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