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FACILITIES & TECHNOLOGY: THE TRANSFORMATION OF "CAMPUS"

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CONTENTS

Introduction:
Facilities & technology: The transformation of "campus"

Hardly an aspect of higher education remains untouched by technology. Nearly every classroom, library, and lab has been reshaped in some way by fast microprocessors, near-limitless data storage, and creative software.

Furthermore, technology is not finished transforming higher education. Massive open online courses (MOOCs), flipped classrooms, and adaptive learning systems are disrupting the Socratic sage-on-a-stage model of teaching that has dominated since the Middle Ages. Research projects are evolving into multi-institution, multinational collaborations dependent on the visualization and analysis of petabytes of data. Institutional management now depends on the functions of millions of lines of code running in vast enterprise resource management systems.

The campus—the actual physical campus, composed of buildings and grounds, parking lots and sports facilities, dorms and research labs—might appear only slightly affected by technology. Yet, technology is indeed reshaping the planning, design, operations, and management of the entire campus built environment. Campus facilities are designed using advanced modeling systems; they are managed via complicated building automation systems. Moreover, the potential for transformative technological change in facilities is growing rapidly. Sophisticated sensors will soon measure water pressure or current flow at thousands of points. Comprehensive energy management systems will balance electrical generation and consumption across entire campuses. Business intelligence systems will leverage facilities investments.

However, technology will actually change the campus in even greater, more fundamental ways. Technology is transforming the whole idea of "campus."

Not so long ago, almost every interaction between the student and the institution took place on campus grounds. Today, students can graduate without ever setting foot on an institution's campus. That is, if the institution even has a campus to begin with—a handful of online colleges and universities do not have traditional campuses at all.

Few institutions will go that far. The campus environment will remain essential for the vast majority of colleges and universities, but its role will change. It will serve a strategic purpose, providing a hub for collaboration, a home for research, and a socio-emotional anchor for the campus community. The whole notion of the campus is changing, thanks to innovations in technology.

Where we are now

Higher education faces numerous pressures, and these pressures are continuining to take their toll on the campus', physical infrastructure. **Financial pressures** make it difficult for institutions to invest in new construction, renovations, and maintenance. At the same time, **pedagogical shifts** are placing the focus of the classroom on the learner rather than the instructor. This situation is exposing the constraints of traditional building designs and creating the demand for new learning environments.

Demographic changes are accelerating, increasing the number of minority and nontraditional students. Colleges and universities are struggling to adapt the campus to these new learners, but clearly the entire institution, the campus infrastructure included, will need to become more flexible and responsive to their needs.

Competition plays a mixed role on campus. On the one hand, institutions competing for students can be forced to offer deep discounts, therefore limiting the funds available to update and maintain the built environment. On the other hand, the campus remains a showpiece, with visiting students and parents scrutinizing recreation

centers, residence halls, dining options, and the actual buildings associated with their targeted program or major.

How buildings and the built environment are changing

New campus facilities are generally "lighter"—that is, they have less internal mass. They are more like shells in which functions can take place. Buildings can be considered as "event space"—space that is **adapted and configured** for a particular use and then readapted and reconfigured when needs change.

Campus uses increasingly overlap on campus spaces. Facilities were once single-use buildings, but today **boundaries are blurring**. A residence hall might include classrooms and a coffee shop; an academic building might house a variety of units or functions engaged in collaborative projects. Mixed-use buildings require sensitive design as well as flexible management. The needs of different users must be balanced for the good of the whole institution.

The changes swirling around the campus only serve to increase the **importance of the core**. The central heart of the campus anchors the institution. It supports the identity of the college or university and provides a potent socio-emotional symbol for students, faculty, alumni, and the community. Even if institutions choose to reduce their campus functions, shedding nonessential facilities on the periphery, they should invest in the core. Its socio-emotional worth outweighs other costs.

Where technology is taking us

Technology is driving higher education to become more connected and more flexible. Students arrive on campus with multiple Internet-connected devices—as many as seven each, according to some surveys. They expect to be **online nonstop**, and they demand ubiquitous high-speed access as an entitlement. Interactions among faculty members and students are likely to become more informal—an ongoing exchange online rather than a potential biweekly encounter across a desk.

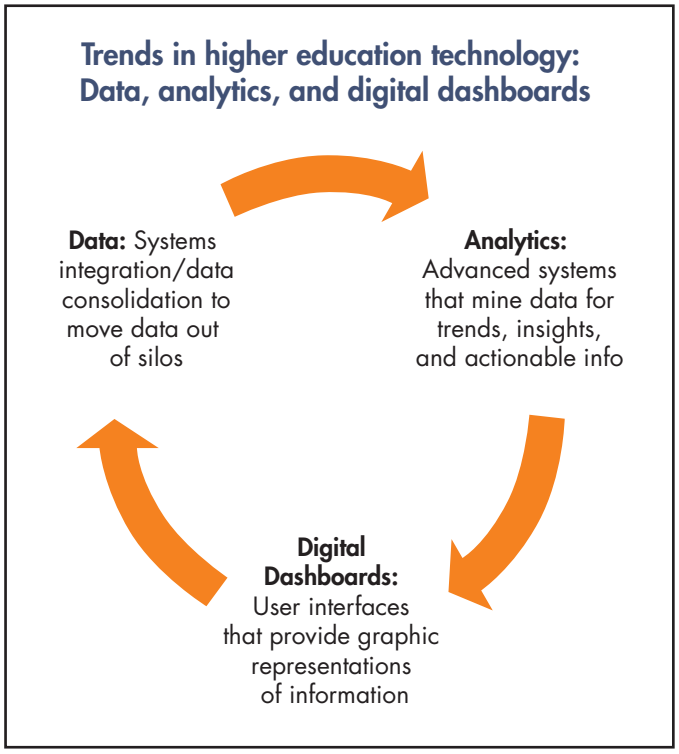
Meanwhile, technology is steadily increasing the options available to learners. Most students likely will take advantage of **multiple types of learning experiences** in their college careers. A few courses will be traditional lectures, delivered by a professor at a podium. Many others will be hands-on collaborative classes or even flipped courses, with lectures online and "homework" moved to class time. Some classes, perhaps those outside of the student's major, will be taken online, and some grades might not be for courses at all but will be assessed via an e-portfolio for a student-driven competency-based learning experience.

Looking ahead: Big trends in big data

Digging into the technological innovations that will change the campus going forward, the theme of big data is inescapable. In the context of higher education, big data encompasses three major trends.

Data/systems integration. The era of stand-alone systems is quickly coming to an end. Colleges and universities recognize that data has limited value when isolated in a single database but enormous potential when systems are integrated and data is consolidated.

Analytics. With data resources at their fingertips, institution personnel can use advanced analytics to make predictions, draw conclusions, and support decisions.



Digital dashboards. The results of data analysis need to be presented to users in clear easy-to-understand ways. Well-designed real-time interfaces will provide graphical representations of critical information and enable users to drill down to critical details.

These trends are shaping technology across higher education. Learning analytics systems promise to integrate data from multiple student information systems, analyze it for trends and insights, and present it to students and instructors via dashboards and alerts. Administrative systems will consolidate and present financial data to senior administrators, while human resources (HR) systems will do the same for employee information. Senior facilities officers anticipate a day when detailed data about buildings is consolidated, analyzed, and displayed in clear actionable ways.

Although the details of big data vary from use to use, the potential impacts are huge. Students will thrive in courses when they know exactly where they are succeeding and where they are falling behind goals. Facilities organizations will achieve greater efficiencies when they understand exactly where building systems are failing to perform at optimal levels. Integration, analysis, and digital dashboards could result in changes on campus that are as dramatic as the introduction of cheap personal computers or the development of the Internet.

Understanding the evolving role of technology in the built environment

APPA developed the Thought Leaders series to examine important trends and issues shaping college and university campuses—and few trends are having more impact than technology. For the 2015 symposium, experts in technology joined senior facilities officers as well as leaders in academics, finance, HR, and student affairs to consider where technology is taking higher education.

The group began by considering where technology and facilities stand today. They looked at trends changing college and university campuses and evaluated the state of the art in higher education technology. The symposium then focused on the role of technology in critical campus functions, including student success, research, HR, campus security, and energy management. Big data plays a major role in all of these functions; implementation of new analytics systems will be challenging, but the benefits will include improved campus services, reduced costs, increased efficiency, and a safer, more sustainable campus. Finally, Thought Leaders participants turned their attention to the nuts and bolts of integrating technology and to identify the characteristics of successful facilities organizations and facilities professionals in the future.

The results of the participants' two days of hard work are captured in this report. This whitepaper summarizes the discussions at the symposium and also provides additional context about major points. The purpose of the report is both to inform readers and to prompt discussion on campuses. At institutions across North America, senior facilities officers have come to rely on the annual Thought Leaders publications to generate new ideas about the built environment and facilities management.

Conclusion

Technology poses both challenges and opportunities for higher education. Innovation happens so fast that institutions fight to keep up with change. Time, effort, and insight are needed to prioritize the investment of college or university resources. IT departments face nonstop demands from all sides, and at the same time cope with the same slashed budgets as every other campus unit, while facilities organizations must adapt to new operational and strategic environments.

The institutions that embrace and integrate new technology will have an edge in the increasingly competitive higher education landscape. They will better serve learners and support faculty. They will make smarter use of limited resources and advance the safety and sustainability of the institution.
Most important, the colleges and universities that leverage technology will be ahead of their peers in adapting the campus to meet the needs of the 21st century. Institutions must look beyond traditional ideas of the value and function of their built environments. They must see that their campuses extend beyond the physical grounds and buildings into the vast dimensions of cyberspace. The new campus will be more than bricks and mortar; it will comprise lines of code, blinking dashboards, and vast databases. The mission of higher education will advance in positive yet new and unexpected ways as institutions come to understand everything that the "campus" can and should mean.

Section I:
Integrating facilities and technology on campus: Where we are today

The notion of campus is going through a remarkable period of transition and transformation. Once a hub of learning existing in relative isolation—think of the proverbial ivory tower—today the campus accommodates multiple purposes and serves the needs of diverse populations.

The next decade will see the campus change even more rapidly, contracting in some ways and expanding in others. The greatest expansion will be into cyberspace as the current outposts of online teaching and learning grow into full-fledged cyber institutions.

Pressures on higher education and how they shape the campus

The challenges faced by higher education institutions are well known, but their effects on the physical campus are rarely considered. In fact, the campus is changing as the entire academic environment changes.

Institutions continue to face **financial pressures** as state support remains at historic lows. State funding inched up last year, growing at 5.7 percent between 2013 and 2014, according to the State Higher Education Executive Officers Association. Most state colleges and universities continue to rely on tuition dollars for nearly half of their revenue. However, state support for public institutions does not seem to be rebounding to previous levels, as it did after significant economic downturns in the second half of the 20th century. Campus facilities budgets have suffered along with those of other departments. Research shows increases of about 2 percent per year on average for facilities operations and maintenance budgets since 2007. This 2 percent is less than the inflation rate for the same period, so the real dollars available have dropped. Facilities departments have increased productivity, but pressures on the organization mean that it is more difficult every year to keep campuses operating at static, let alone, desired levels.

Data Point:
State support of higher education

Welcome to the new normal

"The new normal no longer expects to see a recovery of state support for higher education such as occurred repeatedly in the last half of the 20th century. The new normal expects students and their families to continue to make increasingly greater financial sacrifices in order to complete a postsecondary education. The new normal expects schools and colleges to find ways of increasing productivity and to absorb reductions in state support while increasing degree production without compromising quality."

—State Higher Education Executive Officers Association, State Higher Education Finance: FY 2014, April 2015

Changing teaching and learning practices shape campuses in significant ways. Institutions today recognize the limitations of traditional lectures and encourage faculty members to adopt more student-focused teaching. The result is a vast **pedagogical shift** on campus. Instead of passive recipients of content, students engage in active learning environments in which they drive their own education. While an exciting trend for students, new learning methodologies present a challenge for campuses. Tradi-

tional lecture halls are an ideal environment for traditional lectures, but they are awkward and clumsy for group projects, in-class work, and discussions. Institutions are recognizing the lack of flexibility in their existing classroom inventory and are developing new designs that support instructors in their efforts to challenge learners.

College and university students are themselves changing as **demographic shifts** ripple across higher education. The diversity of college and university students is growing at a rapid rate as minorities become majorities around the country. For example, the University of California system announced last year that it admitted more Latino students (29 percent) than white students (27 percent.) Diversity in the classroom also encompasses gender (women make up about 57 percent of students) and age (40 percent of undergraduates are over age 25). Institutions are working to understand the wants and needs of a more diverse student body, and clearly the campus will play a changing role. Traditional students who enroll at age 18 often live in residence halls and look to the college or university for both friends and activities, but most nontraditional students are less dependent on the campus. The institution can serve nontraditional students, however, by enabling easy access to resources and support and by increasing the flexibility of when and where courses are offered. Nontraditional students may prefer to attend satellite campuses located near employment centers.

Economic theory says that **competition** is supposed to improve services and cut prices, but the situation is more complicated in higher education. The "arms race" among institutions—the competition for the best and brightest students, faculty, and programs—has created situations such as ever-rising sticker prices for private colleges and universities and correspondingly deep discount rates (the average is 48 percent.) The impact on the campus is dramatic. Students and parents making campus visits value what they can see, and they cannot see intangibles such as excellent teachers and cutting-edge research. They can see comfortable new residence halls, vast variety in dining options, rock-climbing walls in the recreation center, and, as important, existent *and* well-kept buildings in their major of choice. Institutions feel pressured to invest in whatever will attract tuition dollars, and the result can be skewed priorities on campus.

30,000-foot view of the college and university campus

Trends in higher education will combine with trends in building design and technology to create the campus of tomorrow. Another important trend is **the fate of the physical campus**. The growth of online education raised fears that the traditional campus was under threat—that the campus could disappear, replaced by a server farm. Although important concerns, campuses are not going away anytime soon. In fact, the majority of institutions need a physical space dedicated to teaching, learning, and research—a physical *core*.

Nevertheless, how the campus is built and operated is indeed changing. Among the many factors changing the campus, three issues stand out:

1. **Increased demand for flexibility.** Campus buildings have traditionally been purpose-built for a single use. This approach allowed for customization but also limited options for the space. Those limits impose a real cost on the institution, which must build new spaces or remodel existing ones as needs change. New facilities will be designed for maximum flexibility. Higher education facilities experts suggest that institutions think of buildings as "event space"—space that is adapted and configured when a purpose arises, then disassembled when that purpose concludes. To this end, buildings are becoming "lighter"—that is, they are shell structures with quickly configurable internal spaces.

2. **Decline of the empire.** The rigid academic divisions that once split the campus are breaking down now. Academia is growing more multidisciplinary; cross-discipline research is increasingly important. This blurring of boundaries impacts campus space; instead of academic buildings with single owners, spaces now have multiple owners. This situation complicates the control and ownership of buildings. For example, while the school of engineering might have had near total control of the space in its building, matters become complicated when academic divisions need to use that same innovation lab. Shared use, shared access, and shared responsibility will be required.

Data Point:
Public-private partnerships on state campuses

Expansion of private sector investment across the United States

State higher education systems across the country are turning to innovative service and delivery models to meet the needs of their campuses. Recent projects around the country include:

- In 2013, Brown University, the University of Rhode Island, and Rhode Island College, in cooperation with the State of Rhode Island and the City of Providence, announced a $206 million deal with a private developer to redevelop the former South Street Power Station in Providence. The 1.76-acre project will include a new shared nursing education center, student housing, administrative offices, parking facilities, and retail and restaurant space.
- In 2014, the University System of Georgia announced that it had selected a private partner to develop, construct, manage, and maintain student housing on nine university campuses. The $517 million, 65-year concession includes the addition of nearly 3 million square feet of housing.
- In 2012, Montclair State University announced a partnership with Energenic-US, LLC to develop a $90 million combined heating, cooling, and power system for the campus; the company will finance, design, build, and operate the plant under a 30-year agreement.
- In 2012, Ohio State University closed a 50-year, $483 million deal leasing its parking assets to a private consortium.

— Multiple news sources

3. **Growing reliance on the private sector.** Colleges and universities have traditionally been self-sufficient units, but institutions today recognize that the private sector can sometimes meet campus facilities needs more quickly and cost-effectively than the institution itself. Both public and private colleges and universities are forging partnerships with developers and other service providers to build residence halls, manage dining services, maintain buildings and grounds, and finance new construction.

Importance of the core. With the changes coming to college and university campuses, the core of the campus will **grow in importance**. In fact, the changes elsewhere make it essential that the institution retains a central hub—a core. Often this core is historic and imbued with tradition. It both reflects and reinforces the identity of the college or university. Campuses will likely contract around their core, shedding facilities on the margins or handing them over to the private sector. The institution will get the most value from its campus by bringing as many students as possible into the central hub; this valuable asset should be used for core academics so that its importance is reinforced.

Campus experts suggest a **hub-and-spoke model**: the core of the campus is a fixed space (traditionally a long quadrangle with buildings surrounding it) but as the campus extends outward, the flexibility of structures increases as their iconic status decreases. At the outer ring of the campus, facilities could be the responsibility of the private sector, or they could be intended to have an abbreviated life cycle. The edge of the campus could be designed for impermanence, in acknowledgment that we cannot anticipate the needs of the academy of 2040, 2065, or 2115.

Impact of technology on campus design and management. While most discussions of technology in higher education focus on technology use by students, faculty, and staff, advanced systems also play a growing role in the **design and maintenance of facilities** and are changing the campus. Building systems unheard of even a decade ago are rapidly becoming commonplace. New systems track and manage rainwater harvesting, exterior shading, and renewable energy generation. At the same time, traditional systems such as heating, ventilation, and air conditioning (HVAC) and power have grown more fine-grained, adjustable, automated—and complicated. Integrating and optimizing these systems are technically challenging and time-consuming jobs.

Smart building sensors are one of the most promising new technologies. Part of this broader trend is the "In-

ternet of Things" (IoT)— objects that are connected to, communicate with, and can be controlled via the Internet—smart sensors **track building information** (such as temperature, lighting, or water use) and automate operations. The greatest potential of smart systems is to **prevent failures** before they occur. Sensors can identify spikes in water use that point to a leak or can notify building managers if the pressure in a fire extinguisher tank falls below safe operating levels. Data from different systems can be combined for a detailed and larger picture of how well a building is operating, and analytics systems can suggest maintenance schedules. Ultimately, automation will become streamlined. The system will identify a failed part, order a replacement, and schedule repairs all on its own.

Sensors will also help planners and architects **design more effective buildings**. Sensors can generate enormous quantities of data about how buildings are actually used. Corporations are beginning to use employee tracking systems to better understand how staff members are using offices, conference rooms, and shared spaces. Colleges and universities will likely make use of similar systems to gain insights into the actual use of campus space in the next decade.

Data Point: The Internet of Things

Growth in Internet-connected devices predicted to soar

Technology analysis firm the Gartner Group predicts that the Internet of Things (IoT) will grow to 26 billion installed units or specific items in 2020—an almost 30-fold increase from 0.9 billion in 2009.

Defined as "the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment," the IoT will outpace the growth of other connected devices such as smartphones and tablets, which will reach about 7.3 billion units in 2020. Gartner says that the IoT installed base will grow to 26 billion units by 2020.

— Information from: Gartner Group, press release, December 12, 2013

Data Point: Smart sensors and building use

New technology that provides insights into how space is actually used

"The loft-like San Francisco office of software maker Atlassian has an open central amphitheater, where all-staff gatherings and midday boot camp exercises are held. But the office's rapid expansion to 300 employees has led to gripes about conference room shortages. 'We're butting up on growing out of the space,' says Jay Simons, Atlassian's president.

"So, early this year, Atlassian installed heat and motion sensors to track when and how often every desk, room and table was used. The result? Desks were used only 20 percent of the workday; conference rooms an average of 40 percent, with peak use at midmorning.

"Simons says tracking employees' movements in an anonymous way will help guide choices to convert desk space into meeting rooms, or to stagger meetings to accommodate a growing staff.

"'If we're using data to make an environment that people can be more productive in, ultimately that saves us money or helps us make more,' he says."

— Excerpt from: Yuki Noguchi, "How a bigger lunch table at work can boost productivity," All Things Considered, *May 20, 2015*

30,000-foot view of IT in higher education

If technology seems ubiquitous on campus today, hold on to your smartphone, because higher education is only going to grow more connected. Students, faculty, and staff expect high-speed access anywhere, and they demand blazing speeds. Students routinely arrive on campus with **multiple connected devices**—according to the 2014 ECAR Study of Undergraduate Students and Information Technology, 92 percent of surveyed students own at least two devices, and 59 percent own three or more. Along with their laptops and smartphones, students bring tablets, wireless printers, digital gaming systems, smart televisions, and e-readers. The load on campus WiFi is immense and growing.

Even with a wealth of technology at their fingertips, students are still more likely to use their devices for fun than in the classroom. While course management systems (CMSs) are nearly ubiquitous themselves (99 percent of colleges and universities have one), only about one in two students use the institution CMS in all or most of their courses, according to the EDUCAUSE Center for Analysis and Research (ECAR). Furthermore, the majority of interactions with the CMS use its most basic functions, such as accessing course content or managing assignments. Advanced features, such as interacting with instructors or receiving feedback on course progress, still receive little attention from students. ECAR also reports that **students welcome technology in their classes** and would embrace more in-depth use of technology by faculty—72 percent said that they prefer courses with some online components.

Students also welcome the use of **learning analytics**. In the ECAR survey, 60 percent of students said that they were very or extremely interested in receiving real-time feedback about their course progress through personalized dashboards in the CMS. Few institutions currently provide this sort of information. Nevertheless, the analytics trend is increasing, and tools to manage and mine the data reserves of colleges and universities will become widespread in the next decade. A recent EDUCAUSE survey found that 84 percent of institutions considered analytics as more important for institutional success today than two years ago.

What is taught and how we teach it. Looking ahead, technology will have a growing effect on the classroom as new generations of faculty advance through the institution, academic software becomes easier to use, and integration problems are solved. Experts predict that students will engage in **multiple types of learning experiences** when earning degrees. Students might take one course in a traditional lecture-based classroom; another course might be a MOOC; and another might be an informal student-driven learning experience assessed via an e-portfolio. Learning will be adaptive, with technology providing the necessary flexibility.

Ready access to technology will also shift the emphasis from absorbing large bodies of facts to **learning how to think**, reason, solve problems, and communicate. Facts will always be available at the touch of a button, so students need to learn how to access information, use and understand advanced analytics systems, think logically about problems, and present solutions clearly and concisely.

Data Point:
Campus spaces for multiple teaching methods

Teaching online and on campus, from one mixed-use space

Three new classrooms at Purdue University allow instructors to teach both online and on-campus students without compromising quality for either audience. Previously, courses in the Engineering Professional Education program were taught in classrooms designed specifically to record lectures. Tables and chairs were bolted to the floor; huge monitors blocked sightlines; and microphones intended to capture questions from on-campus students had such poor sound quality that students online could not understand a word.

Purdue faculty and technical operations staff members developed requirements for the new rooms, including high-quality sound and a more engaging space for students attending class in person. The final design enables faculty members to move around while lecturing, with the class recorded by a student worker in a control room behind an unobtrusive window. The bad microphones and big monitors were replaced with ceiling-mounted microphones and 90-inch screens mounted on the walls. On-campus students are hardly aware that lectures are recorded; they experience the room as any student-focused classroom. Online students get a more dynamic presentation of material and higher-quality recordings. Already the team is contemplating how to increase the flexibility of the spaces and how they can be used for both on-campus and online learners.

— Information from: Dian Schaffhauser, "Designing learning space for both online and on-campus delivery," Campus Technology, *June 24, 2015*

Challenges and changes in the IT department. The IT department is being asked to serve as a strategic partner within the institution rather than a provider of commodities such as e-mail. Successful IT departments are positioning themselves as **trusted campus experts**, aligned with the institutional mission and vision.

This strategic role is made possible in part by **outsourcing**, which frees the IT staff from the demands of providing campus basics. Colleges and universities have turned to cloud computing to provide commodity services such as e-mail, calendars, and collaboration. The size of the cloud market in higher education has reached $4.4 billion, according to a study by government IT experts at MeriTalk.

Outsourcing helps colleges and universities control costs but generally does not reduce staffing levels; staff members are still needed to manage outsourcing contracts and to provide strategic oversight. In fact, nearly half (46 percent) of higher education IT organizations surveyed by EDUCAUSE in 2014 added new staff members, with many of these new hires—38 percent—brought on to fill new roles within the organization. Some of the most in-demand positions are in vendor management analytics and in project and process management. **Integration and analytics** will be critical in the next decade. IT professionals will need to operate across platforms and functions to solve problems. Getting different systems to work together and share information will be one of the most important tasks of IT; many IT staff members reported in an ECAR focus group that campus leaders did not have a good understanding of the time and expertise required.

Data Point:
Trends in technology in higher education

Important developments in educational technology for higher education

Time to adoption: One year or less

Bring Your Own Device (BYOD): Institutional policy that students supply their own devices—such as laptops or tablets—rather than use institution-supplied or -mandated equipment

Flipped classroom: A teaching format where instructional content is delivered online to be studied outside of class while what would have been homework is performed within class

Time to adoption: Two to three years

Makerspaces: Spaces equipped with three-dimensional printers, electronics, and tools, where individuals can share resources and knowledge, work on projects, and experiment with technology

Wearable technology: Clothing and accessories that incorporate computers and advanced electronic technology

Time to adoption: Four to five years

Adaptive learning technologies: Software and online platforms that adjust to individual student needs as they learn

Internet of Things: Objects that are connected to, communicate with, and can be controlled via the Internet

— *New Media Consortium*, NMC Horizon Report: 2015 Higher Education Edition, *2015*

Section II:
Using technology to enhance critical campus functions

Although we think of the campus as a single unit, in fact, it is a composite of many people, spaces, and functions. Part of the challenge of understanding the campus as a whole is that each of these component parts is changing at its own pace. Some campus functions are leaping into the future and embracing technological innovation; others lag behind, held back by technical challenges, daunting costs, or simple discomfort with change.

For the new campus to achieve its potential, disparate campus functions must pull together, confront the challenge of change, and use technology to its fullest potential. For many campus functions, that approach will mean diving into big data. The theme of big data runs through discussions of technological advances across colleges and universities; in almost every campus function discussed subsequently, progress will require the integration and analysis of data stores.

The exciting news is that success in one function can build on the success of another function. Progress stops being linear and starts making exponential leaps. The collective impact of progress in these areas will be greater than the sum of its parts.

The following campus functions each include a description of the Role of Technology Today; a section on the Potential for Technology in the Future; and a set of Questions for Institutional Dialogue.

- Student success
- Instruction and pedagogy
- Research and grant development and support
- Learning environments and course scheduling
- Human resources
- Financial and other administrative systems
- Auxiliary services
- Campus security and mass notification systems
- Energy management
- Building automation
- Space management and master planning
- Environmental, health, and safety management

Student success

Role of technology today. Technology currently plays too limited a role in helping students achieve success. Colleges and universities collect vast quantities of data about their students, but most institutions do not do much with the data that they have gathered.

Some colleges and universities are beginning to harness the potential of this data to support students. For example, Austin Peay State University created its Degree Compass program in 2011 to help students select courses to stay on track for their degree programs. The system takes into account both the course requirements and the talents and needs of individual students and makes individualized recommendations. As well as guiding students, Degree Compass also provides recommendations to academic advisers and also an array of reports to help the institution develop class schedules. (Degree Compass was purchased by education technology company D2L in 2013 and is now a component of the CMS package Brightspace.)

Potential for technology in the future. Participants at the Thought Leaders symposium suggest that the challenges of integration and analysis will be solved. New systems will provide useful information culled from the mountains of student data—information that will be used to create comprehensive strategies for promoting student success. They will also focus on predicting future learning gains rather than simply reporting what has already happened, and smart systems will identify at-risk students early enough to turn around their performance.

Technology will also strengthen long-term relationships between graduates and institutions. The result will be lifelong learning relationships between alumni and their colleges and universities. This approach not only will help graduates fulfill their potential as productive, engaged global citizens but also will allow institutions to draw on the experience and wisdom of their alumni and create bonds of mutual support.

Questions for institutional dialogue

- What data does your college or university collect about students that can provide insights into their success? How accessible is this data?
- What progress has your institution made in integrating student data from different systems? What is getting in the way?
- Are efforts under way to analyze student data? Can you start with systems already in place? For example, does your CMS offer an analytics function?
- Can you make the case for learning analytics and other student success technologies to faculty, staff, and senior institutional leaders?

Data Point: Student success

Taking responsibility for student achievement

"We all know that the responsibility for educating students is not the student's alone. It is a responsibility that belongs to all of us. And we must adapt to meet students' needs in order to graduate more students."

— Dr. Jill Biden, Remarks at SXSWedu 2015, March 10, 2015

Instruction and pedagogy

Role of technology today. The role of technology in teaching and learning is growing every year. Innovative technology has been a driving force in the shifts in pedagogy that have swept across college campuses. Online courses, not to mention online degree programs, could not exist without video streaming, high-speed data access, and CMSs.

Some of these technologies are beginning to mature, while others are still early in their life spans. The campus CMS, for example, has reached near ubiquity just as first-generation systems are showing their age; institutions are turning to new platforms that will enable them to build what EDUCAUSE calls a "learning ecosystem with tools from many sources." EDUCAUSE notes that the old CMS is being replaced with learning management systems that center on the student rather than the course; they will support students throughout their education while providing students, faculty, and administrators with critical information.

Potential for technology in the future. The gap between potential and results will narrow as technology gets easier to use and institutions invest in training and skills development. The learning environment of the next few decades will incorporate technology as a matter of course. The most significant strides in technology for teaching and learning are expected to make interactions more personalized and targeted. Learning management systems will track student engagement and progress and will alert both students and faculty of danger signals. Learning will be measured more frequently—low-stakes assessments will guide instruction and gauge mastery. At the same time, new forms of testing will focus on higher-level cognitive skills such as solving problems and communicating complex ideas.

Questions for institutional dialogue

- How well does your CMS function for today's demands of faculty and students? Can it operate as a learning management system as well as a course management system?
- How deeply is technology integrated into classrooms? Where could integration be deeper and more meaningful?
- What support do faculty members need to gain the skills and understanding required to make full use of technology?

Data Point:
Teaching, learning, and technology

Arizona State University's ambitious adaptive learning program

Arizona State University (ASU) is known for embracing innovation, and it has gone all-in on adaptive learning. Partnering with personalized learning company Knewton, in 2011, ASU moved all of its remedial mathematics courses to a new model that incorporates flipped classrooms, self-paced learning, and in-depth analytics.

Students review mini-lectures and tutorials outside of class, then work through practice problems and challenge tests in class. Students cannot move to a new subject until they have mastered the last. All of their interactions with the system are monitored and reported to the instructor, who can easily see who is falling behind and what concepts they are missing. Students who breeze through the material can take the final examination and complete the course before the semester ends.

Implementing the system was not without problems, but early results seem promising. Knewton claims that pass rates have increased by 18 percent and withdrawal rates have dropped by 56 percent. Nearly half of students finish the course four weeks early. ASU plans to expand adaptive learning to other academic programs, eventually creating an entire adaptive degree program. "We're going to push the envelope," says Philip Regier, dean of ASU Online.

— Information from: Steve Kolowich, "The New Intelligence," Inside Higher Ed, January 25, 2013

Research and grant development and support

Role of technology today. Research would not exist in its current form without technology. As noted by David Lassner, president of the University of Hawaii, research is increasingly interdisciplinary, international, and data driven. Technology enables these shifts, allowing collaboration across departments as easily as across continents and facilitating enormous databases and advanced computation.

Meanwhile, software systems to manage research grants are growing in popularity. These systems promise to reduce the burden of applying for and administering grants by automating budgeting, reporting, and resource allocation. Grant management systems can help researchers demonstrate their effectiveness and productivity and can help institutions support successful researchers.

Potential for technology in the future. Advances in data management technologies and practices will improve data collection and analysis and allow what participants at the Thought Leaders symposium called "one single version of the truth." The vast quantities of data generated by researchers must be managed systematically, with clear institutional policies for storage, ownership, and handling.

Researchers will also take advantage of multiple new technologies on the horizon:

- **Electronic lab notebooks (ELNs)**, software-based recording tools, will replace paper lab notebooks. ELN systems will allow for improved backup and data sharing across teams as well as consistent data collection.
- **Science DMZ networks** will enable high-performance data movement and collaboration. A science DMZ network is a subsection of a larger computer network designed specifically for the exchange of large quantities of research data; it sits between the institution's firewall and the World Wide Web. (The term plays on the notion of a demilitarized zone, a place of limited access that lies outside of a secured border.)
- **Advanced networks** will shuttle data between institutions and enable collaboration. These next-generation networks are restricted to researchers and offer blazing connection speeds. They will allow institutions to collaborate in new ways as enormous databases zip around the world.

Questions for institutional dialogue

- How is your college or university supporting collaboration among researchers within the institution, among institutions, and globally? Should investment in collaboration systems be a priority for the institution?
- How are research grants managed in your institution? Has the campus invested in a grant management system or developed one internally? If not, would such a system help support researchers in applying for and administering research funds?
- Does your institution have policies in place for research data management? Who is responsible for research data? What are the costs and benefits of a formal research data management process?

Data Point:
Advanced technology for research

New era of collaboration

"We are truly moving into the age of 'global instruments.' One institution might have a facility with a visualization capability, while another has an imaging facility, and a third has medical devices integrated with the environment. Rather than imagining all the research 'core' resources as existing on one campus, we are increasingly sharing research infrastructure with peer institutions in a formal, strategic way."

— *Peter M. Siegel, CIO and vice provost for IT services, University of Southern California, in: "Researchers Go Global: Preparing the Next Generation of Innovators,"* EDUCAUSE Review, *October 27, 2014*

Learning environments and course scheduling

Role of technology today. The challenge of technology in the classroom is that the speed of change outpaces the ability of institutions to keep up with such change. Flipped classrooms, experiential learning, and other new approaches are only a few years old—it is not surprising that colleges and universities are struggling to adapt.

Course scheduling, on the other hand, has been little touched by technology—there is nothing "smart" about the process. Space in higher education is still often controlled at the level of the school or department, which owns offices, classrooms, and labs. Institutions that recognize the value—and the cost—of space are moving toward centralized systems that allocate resources based on the needs and priorities of the institution as a whole.

Potential for technology in the future. Classrooms will continue to become more collaborative and student centered. Participants at the Thought Leaders symposium also predict an evolution of technology that faculty and students use to interact with these learning spaces. Participants envision systems that adapt to different instructors so that the room and the systems within it automatically adjust to each faculty member's preferences.

Advanced systems could play a major role in increasing the utilization of space on campus. Centralized scheduling systems could make the most of the institution's investment in its space while matching classrooms to class sizes and teaching requirements. Thought Leaders participants anticipate a more flexible approach to room allocation that allows faculty members to schedule different classrooms depending on what they are teaching that day.

Questions for institutional dialogue

- How well do your classrooms support new teaching methods? How has your institution prioritized updating learning spaces?
- How are classrooms allocated in your college or university? What efforts are under way to improve the efficiency of space utilization? Where is progress occurring, and what is getting in the way of success?

Human resources

Role of technology today. Technology is essential to the operations of higher education HR departments, but Thought Leaders symposium participants believe that it is not used to its full potential. Many HR systems in place today fit an old model, what John Bersin, an HR expert writing for Forbes, calls "systems of record." These

Data Point: Learning spaces

Educational value of student-centered classrooms

New research is starting to make the case for the effectiveness of student-centered learning spaces. The University of Minnesota recently undertook a study to compare learning outcomes in two classrooms, one a traditional lecture hall and the other a new space that the university calls an active learning classroom (ALC). These rooms feature large circular tables with lots of space for laptops and other materials. The walls are lined with dry-erase boards. Instructors are provided with a podium in the middle of the room, where they control presentations displayed on numerous video monitors hung on the walls and ceiling.

In the study, the same professor taught the same first-year biology course to two different classes, one in a traditional classroom and one in the ALC. Researchers found that students in the ALC received higher grades than those that their ACT scores predicted, while students in a traditional room received grades nearly identical to those predicted by their ACT scores.

Observations showed that the classroom influenced the instructor to adopt a more engaged teaching style. Despite the professor's attempts to create identical instructional environments in both classes, she behaved quite differently in a traditional lecture hall than she did in the new classroom, where she interacted more with students. Researchers concluded, "When instructors adapted their pedagogical approach to the new space by intentionally incorporating more active, student-centered teaching techniques, student learning improved."

— Information from: J.D. Walaker, D. Christopher Brooks, and Paul Baepler, "Pedagogy and space: empirical results on new learning environments," EDUCAUSE Review, *December 15, 2011*

back-office systems, operated by HR staff, were built to store and manage employee data. New systems are what Bersin calls "systems of engagement." They are used by employees and managers themselves and are designed to help people work better.

The challenges facing HR technology are familiar ones. Data is trapped in silos and not integrated across systems. While the majority of universities (83 percent) have a data warehouse that stores workforce data across their organizations, fewer than half of institutions (44 percent) consistently integrate this data with other systems such as recruiting and performance management systems, according to surveys by Aon Hewitt, reported in its "2012 Higher Education Survey: The State of HR Effectiveness."

Potential for technology in the future. New HR systems and practices will manage the entire talent lifecycle, from workforce planning through recruitment, onboarding (bringing a new employee into the institution), performance management, and retirement and transition. As many routine administrative tasks as possible will be automated or will become the responsibility of employees working through well-designed employee portals. HR experts will deliver value to the institution by improving talent management and providing insights into ways to improve performance.

Questions for institutional dialogue

- Is your HR system a system of record or a system of engagement?
- How well is HR data integrated across systems? What sort of analysis is possible with HR data?
- Does the institution understand the value of integrated advanced HR systems? Can a business case be made for streamlining transactions and improving analysis?

Financial and other administrative systems

Role of technology today. Nearly all colleges and universities have a financial management system in place, although these systems are aging—according to research by ECAR, on average, they are 13 years old. On the

whole, these systems work. They may not be glamorous, but they are operational.

Two factors are challenging these established financial and administrative systems. First, 13 years is old for enterprise software. Many systems are nearing the end of their lifecycles. Second, colleges and universities have recognized the value of the data within these systems. Administrative and financial IT has the potential to be a strategic asset for improving the operation of the institution.

Potential for technology in the future. Next-generation financial systems will provide real value to colleges and universities—increasing efficiency, lowering costs, and improving operational performance. Colleges and universities should take advantage of the opportunity to upgrade new systems as existing systems age.

The greatest potential benefit of new systems lies in analytics. Colleges and universities cannot move to data-driven decision making without access to data and sophisticated tools for analysis. New tools should provide dynamic reporting capabilities that show data in real time. Business intelligence dashboards should display information by using easy-to-grasp visualizations, and users should be able to drill down beyond top-level summaries to explore data in depth.

Questions for institutional dialogue

- How old is your institution's financial system? How well is it operating? How is it integrated with other IT systems? Is replacing the system on the agenda of the college or university?
- What is the business case for investing in a new financial solution with greater analytical capabilities?
- What sort of advanced analytics and business intelligence tools are available to decision-makers in the institutions? Can these capabilities be added to existing systems?

Data Point: Consolidation of administrative processes

Creation of a single enterprise resource planning system for all Colorado community colleges

In 2004, the Colorado legislature mandated that the 13 community college systems in the state move to a single integrated enterprise resource planning (ERP) system. Previously, each college operated its own customized ERP system, making campus-to-campus comparisons difficult. Institutional policies varied across colleges, and maintaining different software versions required significant IT support.

Technical deployment of the ERP system was complex, requiring a system that could handle transactions from 13 different colleges in a single shared database. However, aligning business processes was harder. Everyone had to agree on points such as the criteria for issuing an incomplete for a course.

The result is a system that provides consistent data for comparison and analysis. The new system has reduced IT support costs and enabled small colleges to have the same functionalities as larger colleges. Most critical, according to Julie Ouska, CIO and vice president of information technologies for the Colorado Community College System, "The standardization of data elements and processes delivers ongoing operational savings in our business functions and enables effective data analysis across the system."

— Information from: Julie Ouska, "Consensus, compromise, and persistence: Implementing a single ERP for 13 colleges," EDUCAUSE Review, *July 14, 2014*

Auxiliary services

Role of technology today. Auxiliary and ancillary services, from housing to dining to bookstores, have faced intense pressure to increase efficiency while adapting to new demands. Many auxiliary services operations have risen to the challenge. Dining, housing, and other services are frequently self-supporting, and may contribute to the campus bottom line. The smart use of technology

has supported these improvements. Systems to manage housing, materials and purchasing, and events have increased productivity and profitability. Driven by retail experiences in the private sector, students will demand similar systems on campus such as shopping carts, real-time account status, learned buying habits, and interfaces with smartphones.

Digital identification (ID) systems have played a big part in these improvements. Many campuses now issue a single smart card or "one card" to each student to access buildings, check out books from the library, take buses, and buy meals. This approach has posed a significant technical challenge that requires interactions among multiple systems with a high degree of security.

Potential for technology in the future. Auxiliary services will continue to focus on improving services while controlling costs. Savvy institutions will make increased use of analytics to assess how customers use campus services and then will target their efforts. The potential for sophisticated data analysis is enormous. For example, residence hall roommates could be matched based on similar traits in the same way that dating services match potential partners.

The most visible technical advances will likely come from innovations in identity cards. Today, most institutions (76 percent, according to Ingersoll Rand) use cards with traditional magnetic stripe technology, but magnetic stripes are notoriously vulnerable to hacking. New systems will use a computer chip embedded in the card. As well as being significantly more secure, chipped cards can be "contactless" so that they can simply be in close proximity to a sensor to work.

Technology is rapidly advancing to the point when students will not need cards at all, only their smartphones. Thought Leaders participants anticipate that smartphone-based systems will only be the beginning. The growth of wearable devices such as the Apple iWatch could usher in an era when sensors recognize individual users the moment they walk by a sensor.

Questions for institutional dialogue

- How have auxiliary services at your institution responded to demand for high services at low cost? What challenges have yet to be solved?
- What is the potential benefit of business intelligence and advanced analytics for auxiliary and ancillary services? Can you make the business case for investing in new systems?
- How does your institution handle access and identity management? Does the campus have plans to move to more secure contactless cards?
- Is smartphone-based identity management on the agenda at your institution? What are the technical challenges that must be solved to implement this approach?
- How can technology enhance the sustainability of auxiliary operations?

Data Point:
Improving campus auxiliary services

Smart social media and campus dining

Boston University (BU) Dining Services has earned a reputation as one of the best users of social media in higher education. The organization's Twitter feed is particularly well managed, engaging students with humor and tact.

When a student posted a plea that one dining hall was out of ketchup, @BUDiningService responded, "We're on it!" Within minutes, the ketchup was refilled. Questions about meal plans are answered carefully and promptly. Fun touches keep students engaged. When one student tweeted that she was craving shrimp cocktail, the staff whipped one up for her.

@BUDiningService is a major commitment for BU and Aramark, its food service provider; social media management is the full-time job of one employee, Aramark's Robert Flynn, and he is committed to keeping up with posts seven days a week, morning and night. "It's a constant thing," Flynn told Boston Magazine. "We're always available for the students, and that's what it's about. If the students are awake, we'll try to be awake with them."

— *Information from: Eric Stoller, "#NomNomNom: Social media and campus dining,"* Inside Higher Ed, *September 4, 2012*

Campus security and mass notification systems

Role of technology today. Technology has proven to be an essential component of security on modern campuses. When a gunman opened fire at the Florida State University Strozier Library in November 2014, police credited the campus security measures with quickly controlling the situation and limiting the number of casualties.

Technology underlies many security best practices. Building access is controlled through ID cards; the best systems know who is in which buildings at all times. Video surveillance systems both provide live feeds and store footage of campus locations. Communications systems allow individuals to report incidents, while mass notification systems alert the campus community of risks.

Potential for technology in the future. Advances in all aspects of security technology promise to improve safety for students, faculty, and staff. For example, institutions are now investing in new video surveillance systems that are connected to the campus network (as opposed to traditional closed-circuit television), allowing security staff members to view video feeds online and quickly share footage with local police forces. Institutions are seeking to strengthen communications systems, recognizing that in an emergency, cellular networks are likely to be jammed with calls.

Mass notification systems are growing more powerful as they become better integrated. Messages can be delivered via multiple systems—text messages as well as automated phone calls, desktop alerts, and even projection screens in classrooms.

Questions for institutional dialogue

- What systems are in place to control access to buildings? If your institution relies on traditional keyed doors, is moving toward carded access a priority? What other systems are available to monitor and control building access?
- Is video surveillance on campus widespread? What sort of remote access is available for both campus and local police?
- How well does the cellular system operate on your campus? In the case of an emergency, would the system quickly overload? What steps can the campus take to ensure that communications will not go down in a crisis?
- How many options are available for mass notification?

Energy management

Role of technology today. Advanced energy management systems have helped colleges and universities get a handle on their energy use. They have helped institutions track their energy consumption with sub-metering systems that enable a fine-grained look at electrical use down to the room level. Innovations in renewable energy have also allowed colleges and universities to start powering their campuses themselves. Higher education serves as a living laboratory for explorations of green energy approaches.

The greatest challenge for most institutions remains the cost required to take advantage of new technology. Most campuses operate with a mix of old and new buildings, building systems, and energy infrastructure. Investments in high-efficiency upgrades must compete with other campus priorities.

Potential of technology in the future. Thought Leaders participants expect that energy management solutions will become less expensive, easier to use, and more automated over the next decade. New systems will provide facilities managers with more data about energy use while integrating with building management and business systems. Future systems will also supply users with data about their energy use along with information on how to cut consumption. Colleges and universities will educate smart consumers, who will make responsible decisions about energy throughout their entire lives.

Thought Leaders participants anticipate that campuses will increasingly become "microgrids"—that is, self-contained energy networks that generate, store, and consume electricity. Microgrids normally connect to the regional electrical grid but can disconnect and operate in "island mode" in the case of power outages. As well as increasing reliability, microgrids will be equipped with the most advanced smart grid technology to provide continuous monitoring of energy consumption and generation.

Questions for institutional dialogue

- How much data about energy use is available to your institution? Can you monitor consumption on the level of academic units? Buildings? Offices? Dorm rooms?
- What strides has your campus made in energy-efficient systems? Where would additional investments pay off for the institution?
- Is your campus generating any of its own energy? Could facilities management develop partnerships with academic units to develop renewable energy projects?
- How can you engage the campus community as an energy conservation champion?

Building automation

Role of technology today. Building automation systems (BASs) are a product of advanced technology. Next-generation building automation is driven both by technological innovations and business factors. Colleges and universities see enormous potential to improve the efficiency of their facilities with smart responsive systems. However, increased functionality has created increasingly complicated systems that are a challenge to operate. Staff members need new skills to understand and maintain advanced automated buildings. Senior facilities officers welcome the new data available but struggle to translate it into actionable intelligence. Analytics tools need to catch up with automation.

Potential for technology in the future. Ease of use, interoperability, and integration will increase as technology improves and vendors respond to facilities managers' needs. New systems will be designed with analytics in mind. The quantity of data will grow, thanks to the Internet of Things, along with solutions for mining that data.

The BAS will be based on open standards rather than proprietary software. Cloud-based platforms will allow plug-and-play integration of the components best suited for individual institutions. Self-diagnosing and self-healing systems will assess their own status, correct problems when possible, and notify the staff when service is required. The role of the facilities manager will be as much to supervise systems as to supervise staff.

Data Point: Energy management

Development of a microgrid at University of California San Diego

The University of California San Diego (UCSD) is pointing the way for colleges and universities seeking to optimize energy use. The campus operates a sophisticated microgrid that generates 92 percent of the electricity used by the campus of 45,000 people, 450 buildings, and nearly 2,000 acres. Power is produced in a cogeneration plant, via a fuel cell (at 2.8 megawatts, the largest such cell on any campus), and through solar panels. Excess energy is stored in a variety of systems, including batteries and a thermal energy storage system. Energy use is constantly analyzed via a system known as the UCSD Master Controller, which integrates power system analytics and optimization software that plans and schedules generation, storage, building management systems, and demand load.

While focusing on reliability for the campus, UCSD also operates its microgrid as a lab to test energy innovations. For example, it recently installed a shipping container housing worn-out electric vehicle batteries; no longer able to operate cars, they can still hold enough charge to store energy for the microgrid. If it works, the system could provide a second life for the batteries and reduce waste.

— Information from: Power Analytics, "ESDA, UC San Diego, and Viridity Energy unveil new generation smart grid at California Higher Education Sustainability Conference," press release, June 21, 2010

Questions for institutional dialogue

- What data does your BAS provide to your facilities operation? How can you make use of this data to improve efficiency and advance the strategic goals of the institution?
- How closely integrated are the buildings, building information systems, and building automation systems on your campus? Can you get a comprehensive view of the campus and how it is functioning? What components of a fully integrated system are missing, and can you move toward adding them?
- What skill sets and training are needed to support the gathering of the best information possible from the BAS?

Space management and master planning

Role of technology today. Higher education campuses are planned, designed, constructed, and managed, with technology playing a role every step of the way. Colleges and universities have assembled toolkits that incorporate geographic information, building information modeling, and facilities information management systems. While powerful, these systems have their limitations. Greater integration would greatly increase their impact. Systems are often highly technical, and translating the data they contain into information that makes sense to a general audience is challenging.

As a result, master planning is often perceived as an exercise that contributes little to the real world. That perception is a missed opportunity. Master plans should be living, breathing documents that inform both long-term visions for the campus and day-to-day use of buildings and grounds. Technology does not yet empower campus planners and facilities managers to fulfill the potential of the master plan.

Potential for technology in the future. Thought Leaders participants believe that master plans can become more powerful and dynamic through technological innovations. They imagine being able to show administrators how different options would shape the campus. All sorts of scenarios could be played out in real time—for example, changing traffic patterns, adding new classroom buildings, and increasing enrollment.

Such a system is still in the future, but it would build on the technology now under development. New space management systems will consolidate data into a single integrated system. Straightforward metrics will draw clear lines between the institutional priorities and the facilities operations and plans. Predictive analytics will assess the impact of proposed changes to the built environment. Most powerfully, improvements in space management and information systems will take the master plan off the shelf and into the real world. Plans can become dynamic documents that are adapted as needs shift.

Questions for institutional dialogue

- What tools are available to your institution today to plan and manage space on campus? How closely integrated are these systems? What advances in technology could benefit these functions?
- How clear is the connection between the campus planning and facilities management function and the institutional mission and vision? How can you make these links clearer to stakeholders and institutional leaders?
- How old is your campus master plan? How often is it consulted when making decisions about the campus? What steps would be necessary to make the master plan a dynamic resource?

Data Point: Master planning

Importance of data-driven decision making

"Institutions who know their value to society can show it through measurable outcomes. … Using sophisticated data analysis and tools for decision-making steps up the level of sophistication that university partners are able to add to the process, whether it be programming, construction, allocation of space, etc.; it is used to assess current environmental impact, set institutional goals, and measure performance."

— Society for College and University Planning (SCUP) Academy Council, "Report on Trends in Higher Education Planning 2014," 2014

Environmental health and safety management

Role of technology today. The potential of technology in environmental health and safety (EHS) management in higher education has yet to be fulfilled. Certainly technology is essential to EHS management today. Colleges and universities rely on reports, databases, and spreadsheets for record keeping and compliance. However, few institutions have invested in specialized software to improve the management of EHS functions, according to Matthew Littlefield, the president of consulting firm LNS Research, in a recent article on environmental health and safety. Littlefield says that in addition to failing to use specialized systems, institutions rarely integrate EHS data with other campus information systems. The result is an island of data that fails to bring added value to the institution.

Potential for technology in the future. Smart use of technology has the potential to elevate EHS activities from simply a compliance function to a more integrated and integral role on campus. By automating routine tasks and integrating data from across the institution, EHS systems could promote a safety culture, improve the efficiency of campus operations, and better manage risk. New technical solutions will streamline the record keeping that is the backbone of compliance, while new systems will integrate EHS data with other campus operations and management systems for real-time use and making evidence-based decisions.

Questions for institutional dialogue

- What sort of technology does your institution use in EHS systems today? Can you make the business case for investing in new EHS systems?
- How well is EHS data integrated with other campus systems? What opportunities exist to automate the data integration for improved record keeping and compliance?

Section III:
Integrating facilities management and information technology

Executing the transformation of the college or university campus will be the responsibility of the facilities professionals within higher education—and it will not be an easy task. New technology will require new skills and new approaches to day-to-day tasks. The result, however, will be a new campus for a new era, one where technology supports smart operational decisions, enhances teaching and learning, and fulfills the mission of higher education to educate responsible global citizens.

Restructuring the facilities management organization to effectively integrate new technology

Facilities management departments were not designed with technological integration in mind. **Internal reorganization** will be necessary to prioritize systems integration, automation, and business process intelligence. The changes required will depend heavily on the size and type of institution. Large research universities will likely need to expand dedicated technical groups within facilities management to address work management, hardware maintenance and renewal, software and data management, building automation, energy accounting, campus enterprise automation, materials management, SCADA (Supervisory Control and Data Acquisition), space data, GIS, and more. Smaller campuses will need to reconfigure staffing to establish a dedicated technology group to address building and business automation systems, as well as strengthen partnerships with their colleagues in IT. Facilities organizations with limited technical capabilities at the institutional level should consider partnerships across state systems or among private institutions.

Integration with Information Technology. No matter how large or small the campus, the facilities department needs to **strengthen relationships with the IT department**. Ties can be formalized with designated liaisons but should also rely on more informal personal connections across all levels. Improved relations can start with something as simple as lunch between the senior facilities officer and the CIO once a month. The important consideration is that both Facilities Management and IT recognize the mutual benefit of a better understanding of roles and common interests.

Identification of Common Tools. There are many opportunities for collaboration to build or make available common tools that can benefit both Facilities and IT, such as 1) a space database of all IT-related server rooms, data centers, and data hubs; 2) GIS mapping of IT infrastructure; 3) data center information systems; 4) GIS inventories of audiovisual equipment by classroom/lab; and 5) preventive maintenance scheduling coordination.

Coordinated Support Systems. Collaboration to coordinate services and support of classroom technology, such as a classroom hotline, after-hours service response, component renewal, parts inventories, maintenance stocks, and work management.

Crafting policies that enhance facilities/IT integration

In the long term, the **lines between IT and facilities will blur** as technology becomes tightly integrated within the fabric of the campus. If this prediction sounds outlandish, keep in mind that this year Google filed a patent for technology that turns any wall into a touchscreen. If the walls of the campus are themselves interactive technology, where does IT end and facilities begin?

As they adjust their structure and amp up their professional goals, facilities organizations also need to assess their **internal policies** to ensure that they are up to the challenges of current technology.

Security. Security is a primary concern. Powerful systems create unprecedented risks. Hacking a building automation system, for example, could wreak havoc on a campus; an inadequate password could put an entire campus at risk. Facilities organizations need to partner with IT experts to create stringent cybersecurity protocols in line with the enterprise as a whole.

Hardware and Software Procurement. Facilities organizations should also consult with IT departments to develop **policies for testing and approving new software and equipment.** New facilities systems are too complicated and mission critical for their selection to be ad hoc. A process should be put in place for assessment, selection, rollout, and support. Standards need to be set to vet new solutions, especially when the goal is to increase integration and interoperability. New systems need to be able to talk to one another; it is likely that they will rely on the same open source platform.

Creating successful facilities/IT integration

Senior facilities officers will need to consider dozens of details to harness the potential of technology, and transparency and participation are key in the decision-making process. Some critical points brought up in discussions at the Thought Leaders symposium include the following:

- Identifying synergies between Facilities and IT. Make the effort to identify mutually beneficial improvements and tools.
- Building maintenance and IT maintenance cycles should be coordinated. Communication will make maintenance easier for both organizations, especially for mission-critical data centers and communication hubs.
- Commissioning should include an IT component to ensure that the technology within new buildings, both building systems and user systems (such as audiovisual equipment in classrooms), is operating at peak capacity.
- Clear responsibility and clear line of authority need to be established for technology decision-making across the campus. All systems and software need an owner.
- While IT can support Facilities with advanced technology, Facilities can support IT with sustainability. The departments should find ways together to cut energy costs and improve the efficiency of IT operations.

Data Point:
Benchmarking to improve operations

Reliance on APPA operational guidelines to shape facilities management

"We [Philadelphia University] are small, tuition-driven, and private, with the desired ability to be nimble. We're not heavily endowed but are committed to sound financial management. It's vital to understand which standards must be reached and which are not practical. So, given our resources, it is not the University's priority to be a showplace facility, but everyone from the president on down to staff must agree on the established expectations.

"APPA's tables of standards are invaluable. They show everyone involved what the best practices and expectations should be for an institution operating at a desired level. For maintenance we commit to Level 3, managed care, and strive for Level 2, comprehensive stewardship.

"In grounds we adopted and customized the APPA tables creating a campus plan with mapped maintenance zones, detailing services, and we categorized every plant as native, invasive or non-native/non-invasive. Our costs are level, but we're getting more bang for the buck. We're practicing sustainability, keeping some spaces more meadow-like with native plants, but our greens are sharp, and our highest impact areas are showplaces."

— *Thomas Becker, associate vice president of operations at Philadelphia University, quoted in: Anita Blumenthal, "Getting Better all the Time: New Thinking & Rethinking Generate Innovative Strategies, Best Practices," APPA's* Facilities Manager *magazine, July/August 2013*

- Planning and design guidelines need to address technology. Technology requirements should be as clear and straightforward as lighting or furniture specifications.
- IT and facilities departments should establish procedures for working together that include clear assignment of roles and responsibilities and clear lines of communication.
- Master plans must be coordinated to include concepts and standards important to Facilities and to IT.
- Collaborate and reach consensus on designs for mission-critical services so that maintainability and system redundancy can be retained. Include energy efficiency goals at each step of the design.

Data Point: Facilities systems integration

Increased energy efficiency with an integrated facilities management system

The San Mateo County Community College District recently announced the implementation of a new comprehensive system to maximize energy use while integrating facilities information. The system incorporates building control, energy management, and building analytics into a single platform that allows facilities managers to visualize, analyze, and implement energy performance strategies. With real-time analysis and actionable suggestions, the system is a glimpse into the future of the integrated building systems that experts predict will soon be found on campuses across North America.

— Information from: Joshua Bolkan, "California community college district aims to improve energy efficiency with analytics," Campus Technology, *July 9, 2015*

Facilities professional of the future

Facilities experts will need to change along with their departments. The **demands on facilities professionals** have grown over the decades, but technological innovation poses unprecedented challenges. Facilities managers must learn how to function in a multidisciplinary world and communicate with a wide variety of audiences while mastering professional skills, technical innovations, and global competencies. Their time will be spent on ideas and insights rather than routine maintenance and management. A commitment to the continuous training of employees is critical.

The greatest value that facilities professionals will offer their institutions will be as **super strategists**. They will leverage the data available to the organization to spot trends and adapt proactively. Reactive maintenance — something fails, and someone goes to fix it—will be trumped by proactive, planned maintenance. Looking ahead, facilities management will become more proactive. Facilities managers will identify and implement integrated cooperative strategies.

Certainly technology will facilitate this process. The Internet of Things will create a campus buzzing with **smart equipment** that will monitor and communicate the slightest deterioration in performance. The idea of facilities without failures—no water leaks, no broken wires, no stalled elevators, no hot/cold calls—may seem far-fetched, but new technology will bend the curve toward failure rates unimaginable in previous eras.

However, technology will only achieve its full potential if it is managed by facilities professionals with an **ambitious strategic vision** of the future. The most successful leaders will be ones who use technology to resolve problems that no one ever imagined were solvable.

Imagining the IT/facilities integration of the future: where we are going

The potential of technology and facilities integration is difficult to grasp. Undoubtedly, facilities professionals of the future will invent systems impossible to predict today. However, some innovations are not only possible but probable within the next 5 years to 10 years. The technology for the solutions discussed in the rest of this section does not yet exist—but it will, and participants at the Thought Leaders symposium predict that the campus of tomorrow will see these developments soon.

Personalized learning and work spaces. Technology will recognize students, faculty members, and staff personnel the instant that they walk into a room. Buildings

Data Point:
Developing future facilities professionals

Engaging high school and college students with a global (even intergalactic) initiative

The professionals of the future are gaining insights into facilities management challenges that Earth-bound experts can hardly imagine by participating in the Mars City Facility Ops Challenge developed by the National Institute of Building Sciences, Total Learning Research Institute, NASA, and International Facility Management Association.

The program allows students to perform as facilities managers responsible for maintaining a virtual base on Mars. High school and community college students will work as teams to keep the water, energy, HVAC, and other building systems operational—on another planet.

While a simulation, the project uses an actual building information model of the Mars City facility developed by professional designers. Teams will employ professional maintenance software in scenarios developed by teams of facilities management professionals. As well as furthering science, technology, engineering, and mathematics (STEM) skills and promoting interest in facilities management careers, the Mars City project will build skills needed by 21st century facilities professionals: teamwork, communication, and a global perspective.

— Information from: National Institute of Building Sciences, "Buildings-focused STEM education program reaches important milestone," press release, July 24, 2014

will respond to users, customizing spaces to meet their needs. Responsive spaces will increase engagement with students and faculty, making even classrooms and labs adapt to users.

Powerful, real-time facilities information management systems that integrate data, increase efficiency, and improve the credibility of decision making. Powerful platforms will streamline the day-to-day activities of facilities management, from ordering parts to tracking maintenance histories and calling up building plans. The system will start at the ground level, managing the details of operations, but will extend all the way to top-level management, with tools for predictive analytics and business intelligence.

Building designs based on the use of existing spaces. In the past, the campus was the invention of administrators, donors, and architects who offered ideas about how the campus should operate. Tomorrow, buildings will be designed, in effect, by those who use them, through systems that track how students, faculty, and staff interact with their spaces.

Space management systems that track and allocate campus resources as needed. Space allocation will be examined in real time, then managed with an eye toward flexibility. Staff members who work on laptops will reserve desks when they need focused time but otherwise will share general space. Classes will rotate among rooms depending on what work they are doing that day. Space will be valued as a prized resource and will be conserved for its most productive and important purposes.

Conclusion:
Evolving facilities, evolving skill sets

This report has focused on the evolving idea of the college or university "campus" as higher education is transformed by technology. The campus of the technology age isn't your grandparents' campus. The entire framework for delivering and receiving an education is changing.

It is also clear at this point that as the campus evolves, so too must the skills of facilities professionals. This industry has already undergone a remarkable evolution, as facilities managers undertook new challenges and mastered new skills over the last 50 years. The evolution required in the next 50 years will be even greater. In the past, buildings were static things—they sat unmoving and unresponsive as events happened within them. Soon, buildings will be "alive," sensing the world through sophisticated monitoring systems, deciding for themselves what they need based on powerful algorithms, and communicating their condition 24/7. Managing an entire "zoo" of "smart" buildings, all evolving at a pace faster than any seen before, will place unprecedented demands on facilities professionals, who must become experts in the care of a new breed of campus facilities.

What will it take to successfully manage the new campus? This report introduced the idea of the facilities professional as a "super strategist"; an idea worth emphasizing. A major culture shift is required. Making the new campus a reality will require more than technology. It will require a new way of thinking, one that is fast, adaptive, insightful, and visionary.

Super strategists will keep their eye on the big picture. They'll understand the mission of their institution and harness all the resources at their disposal to reach their desired goals. They'll anticipate what's coming rather than simply reacting to events. Their skills will extend beyond disciplines and departments. They will be integrators, gathering information from multiple sources, looking at it from all angles, and discovering connections in unexpected places.

Sound like an intimidating job description? Absolutely! Super strategists won't just appear out of nowhere. The higher education facilities industry must make a deliberate and sustained effort to develop these capabilities within its ranks. As a profession, we must break down the needed competencies into manageable components and determine how to teach new skills and encourage new ideas. We must scour our ranks for promising individuals with curious minds and wide-ranging vision. We must study both the successes and failures of other industries that have undergone major transformations and adapt what works to our industry.

The stakes are high. For decades, higher education was a stable industry, but this period of disruption could shake the foundations of colleges and universities. We could see losers as well as winners. No one can make change go away by ignoring it. As much as they already have on their plates—and we know you're already confronting myriad day-to-day challenges from aging buildings to tight budgets—facilities professionals need to look to the future and understand how they as individuals can become more strategic in their thinking.

Ask yourself: What don't I know? What am I missing? What connections can I make within my institution to broaden my perspective?

Senior facilities officers should ask questions about their departments as well: Who within the ranks has a multidisciplinary, strategic way of thinking? How can we encourage that approach within the organization? What skills are missing on our team? Does our organizational structure help or hinder integration with IT? How can we position ourselves to be more proactive?
The campus is changing. The professionals responsible for the campus must change as well. Are you ready?

APPENDIX A:
Resources and References

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