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Building efficient colleges and universities

Colleges and universities face a long list of challenges, as do the engineers tasked to help construct and modify the facilities at these institutions. Here, experienced professionals share their knowledge.

CSE: What's the No. 1 trend you see today in the design of college and university structures?

Don Harrisberger: When it comes to colleges and universities, the biggest trend we're seeing is a drive toward sustainable, cost-effective solutions. With constrained budgets and staff, colleges and universities are prioritizing systems that are energy-efficient, low-cost, and can be easily maintained.

Timothy J. LaRose: I'm noticing that the amount of glazing in construction has dramatically increased, which presents challenges for compliance with fire and life safety and other code implications, such as wind-borne debris (projectiles). With the revision of many flood plain maps, the coastal areas may now be subject to more restrictive requirements for protection from projectiles.

Julianne Laue: The biggest trend in the design and construction of college and university structures is not directly in their mechanical, electrical, and plumbing (MEP) systems or architecture, but in the required financial performance of the facilities. There is no longer a "build it and they will come" attitude, and buildings now

need to provide a return on investment (ROI). They need to be able to directly impact enrollment and to attract and retain students. New and renovated buildings on campuses need to be energy-efficient, sustainable, have state-of-the-art technology, contain multifunctional shared spaces, and be flexible and adaptable for the future.

Robin Mosley: The No. 1 trend we see is a demand for detailed energy-efficient integration into the campus master plan and the use of many passive and innovative technologies, such as optimized natural ventilation and low-energy radiant heating and cooling systems. The University of California (UC) is striving to achieve net zero energy in their buildings and maximum efficiency of their central plant infrastructure to help them toward reaching their carbon-neutral goals, such as those in place for the UC system by 2025.

John Teeter: The biggest trend in the design of college and university structures is maximizing energy performance and reducing the environmental impact of the facility. It appears that a number of colleges and universities are shifting away from some of the more traditional rating systems to determine building performance. Instead, many are focusing more intently

on energy-use intensity as compared with their portfolio of buildings on campus and at like institutions.

CSE: What other trends should engineers be on the lookout regarding these projects in the near future (1 to 3 years)?

Laue: There has been an increased interest for colleges and universities to form industry partnerships and strategic affiliations. The "education-industry partnership" or "new vocationalism" model fosters collaboration between colleges and universities and industry. They are looking to develop highly skilled graduates while potentially offsetting the costs of building university-only facilities. An example would be college or university building assisted living or senior living buildings.

This forms educational and social opportunities for both students and seniors while providing a revenue source for the school. Students have access to hands-on learning opportunities while seniors can access educational and social opportunities. In this case, a building may house a nursing school along with living quarters. Designers need to be open to the



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challenges of designing unique multiuse buildings on campuses.

Mosley: Another trend we see is the advancement of alternative project-delivery methods, such as design-build and public-private partnerships, while still maintaining a strong sustainability and energy efficiency focus for campuses.

Teeter: There appears to be a trend with colleges and universities to move away from centrally distributed steam systems to centrally distributed hot water or regional hot-water plants. This is mainly due to aging infrastructure and reduced knowledge on the proper maintenance, operation, and safety concerns associated with steam systems.

CSE: Please describe a recent project you've worked on—share details about the project including location, systems engineered, team involved, etc.

Liza Sandman: Our company was recently involved in designing the new Watt Family Innovation Center at Clemson University located in South Carolina, which is a 66,000-sq-ft facility. The building was designed with group collaboration and flexibility in mind, using a raised-access floor system with demountable wall partitions. There is a large atrium across the front length of the building with a large, LED media mesh screen across the front exterior with LEDs. The building includes innovative technology and connectivity to other areas on campus as well as the ability to share information with other groups across the globe.

Harrisberger: Recently, our company did a renovation of Geffen Academy at UCLA, a university-affiliated school for sixth- to 12th-grade students. The renovation focused on an existing 3-story



Figure 1: Engineers with RMF Engineering provided services in the design of the 66,000-sq-ft Watt Family Innovation Center at Clemson (S.C.) University. Features include a large atrium with an LED media mesh screen across the front of the exterior. Courtesy: RMF Engineering

building. We used package variable air volume (VAV) systems with hot-water reheat and outfitted a laboratory area with fume hoods and laboratory controls.

Laue: The University of Chicago's Campus North Residential Commons is in the heart of Chicago, and blurs the line between campus and community. The \$155 million project spans 400,000 sq ft and consists of four buildings interconnected by various plazas, gardens, walkways, and courtyards. The 800-bed facility includes a dining hall, offices, classrooms, and other common areas as well as 10,000 sq ft of ground-level retail space.

By employing a design-build delivery method and implementing lean building practices including laser scanning and 3-D modeling, the team of Mortenson Construction, Studio Gang Architects, dbHMS, and Magnusson Klemencic Associates was able to complete the project a year ahead of projections. Reflecting the university's distinctive housing system—in which students at all levels live and work together within various houses to elevate social and

academic success—the building's design emphasizes collaboration and connection.

The façade was designed to maximize daylighting and natural-ventilation opportunities while decreasing building energy consumption and optimizing energy performance. Radiant slab heating and cooling embedded in the concrete-slab ceilings with dedicated outside-air system (DOAS) units serve the dormitory rooms. The mechanical systems react with the radiant slabs, DOAS units, natural ventilation, and daylight levels to optimize comfort and minimize energy consumption. Waste drain heat recovery was incorporated to reduce domestic hot-water energy consumption. A waste heat-recovery coil was installed in shower drains to reclaim energy by preheating cold water using hot water going down shower drains.

The residence hall features a structural design consisting of cast-in-place concrete with high-quality precast panels. Four buildings are interconnected by various plazas, gardens, walkways, and courtyards. Located within the larger Campus North Residential Commons, the



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Baker Dining Commons offers a light-filled gathering space with floor-to-ceiling windows overlooking a central quadrangle, as well as two private dining rooms equipped with smart technology. The building also accommodates offices for campus and student life, classrooms, music-practice rooms, outdoor green spaces, and 10,000 sq ft of



Figure 2: Energy efficiency goals are driving the need for renewable energy features (such as the solar panels in the photo), photovoltaic and solar hot water.
Courtesy: Southland Engineering

ground-level retail space. The eight houses accommodate 800 undergraduate students. Each house includes a 3-story common area—called a “hub”—where students can gather, study, and relax. The top-floor reading room offers panoramic views of the Chicago skyline and Lake Michigan. Student room layouts include single and double rooms for first- and second-year students and private apartments with a kitchen and bathrooms for third- and fourth-year students. The building also provides apartment-like living space for senior faculty members serving as resident masters and resident heads for each house. Engineering firm dbHMS will monitor the building energy consumption after the building opens to verify the energy performance. The project is targeted to achieve LEED NC v2009 Gold certification.

CSE: What are the challenges you face when designing college and university facilities that you don't normally face for other projects?

LaRose: The many levels of stakeholders that do not communicate well pose a challenge.

Teeter: The biggest challenge regarding designing projects for college and university facilities is the vast number of stakeholders involved. Many of the stakeholders have wide-ranging priorities that oftentimes are in direct conflict with one another. Limited resources like project budgets, net usable square footage, aesthetics, ease of maintainability, form over function, to name a few, are in a constant tug of war with one another.

Mosley: Some universities have their own clearly developed design standards, which we will incorporate into our designs. Others do not, and we have to provide our expertise, advice, and recommendations to help guide those facilities teams and meet their needs. We sometimes encounter older central plant infrastructure and high-pressure steam systems, which we must use to serve new buildings. Some of this infrastructure is old and inefficient so there are sometimes advantages of creating hybrid plant solutions, which take the load off this aging infrastructure and place it on the new decentralized systems.

Laue: Colleges and universities have complex stakeholder engagements with differing decision-making groups. For these project types, it is important to understand and map out the “authority tree” early in the design process. It is important to understand who the decision-makers are, understand how they align with each other, and assist them in making decisions. Engineers will typically default to discussions with the facilities team. However, those teams may not have authority to make project decisions.

CSE: What are some unique elements/considerations when retrofitting or renovating such facilities?

Teeter: Some of the unique elements for retrofits and renovations is the spatial constraints of the existing buildings. Many colleges and universities have aging facilities that were not originally constructed to accommodate the requirements needed today.

Laue: Retrofits and renovations can get messy quickly. Many times, the buildings are in use during design and engineers

must rely on existing as-built drawings. Once the project starts, the MEP systems can differ from what was shown. This can lead to multiple radio-frequency interferences and time spent coordinating during construction. Design and construction teams need to allow time and budget for coordinating existing conditions during construction. Laser scanning existing conditions can significantly reduce the time associated with existing-conditions coordination.

Harrisberger: Educational institutions need flexible space that can adapt to future changes in class size, teaching styles, and general use of the facility. This means that from both a programming and technology point of view, we need to future-proof as much as possible by building for flexibility.

CSE: What types of smart grid or microgrid capabilities are owners demanding, and how have you served these needs? Are there any issues unique to these projects?

Mosley: We have investigated the use of fuel cells for universities to help provide combined heat and power or backup power to their facilities. The lifecycle costs for these solutions show significant payback time periods, therefore power-purchase agreements are usually the only feasible options to economically install fuel cells on campuses.

Laue: I haven't seen owners demanding microgrids or smart grids. However, we are seeing an increase in requests for the team to study the feasibility of smart grids and microgrids and how they can be added to a current campus system. Owners are looking to reduce costs and ensure reliability while proving research and educational opportunities for students. There is increased interest in understanding options, costs, and how these can impact the campus in the future. **cse**

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