EAB

Compendium of Design and Construction Tactics to Minimize **Total Cost of Ownership**

Facilities Forum

EAB

Who Should Read

Senior Facilities Officers

Third-Party Capital Project Partners

Project Managers

Compendium of Design and Construction Tactics to Minimize Total Cost of Ownership

3 Ways to Use This Resource

- Compare design and construction experiences with past capital project decisions
- Jump-start discussions about total cost of ownership
- Incorporate ideas into design guidelines or other "lessons learned" documentation

Facilities Forum

Project Director

Gary Guadagnolo, PhD

Contributing Consultants

Lisa Berglund, MPP
Elizabeth Denny

Practice Manager

Ann Forman Lippens

Managing Director

John Workman, PhD

Design Consultant

Chanel James

About EAB

EAB is a best practices firm that uses a combination of research, technology, and data-enabled services to improve the performance of more than 1,500 educational organizations. EAB forges and finds the best new ideas and proven practices from its network of thousands of leaders, then customizes and hardwires them into every level of member organizations, creating enduring value. For more information, visit eab.com.

About the Facilities Forum

The Facilities Forum serves Facilities leaders from colleges and universities across North America. Our dedicated research team works to identify and share proven solutions to higher education's toughest operations and maintenance, space management, and capital planning and design challenges. The Forum serves over 150 institutions and their heads of Facilities.

Table of Contents

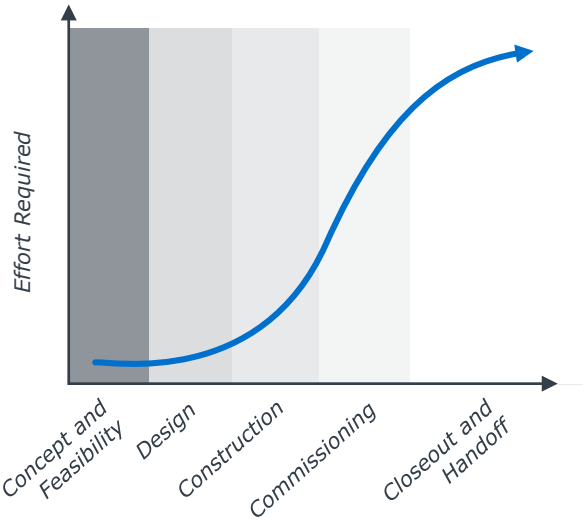
Executive Summary

Considering Total Cost of Ownership in Design and Construction

Applying a total cost of ownership (TCO) mindset in capital project decisions can help reduce costs and optimize the life span of university assets. While TCO-focused decisions may lead to higher up-front costs, institutions recoup savings from lower maintenance and renewal costs.

The greatest opportunity to minimize the total cost of a building is during the design, planning, and construction phases, before decisions are literally cemented into place. Unfortunately, campuses often recognize the right (and wrong) decisions only after the fact. This resource is designed to arm Facilities leaders with an anthology of proven early design and construction strategies to extend the life of institutional assets.

Difficulty of Inflecting TCO Across Capital Project Stages



How to Use This Resource

The first section is a compendium of over 100 design and construction tactics to reduce long-term maintenance costs, as reported by Facilities leaders across higher education. The tactics are grouped into 12 categories (e.g., furnishings, mechanical) according to their design and function. Within each category, each tactic is paired with a rationale for its effect on TCO. Importantly, not every tactic will be relevant for every institution or every project. Rather, the ideas reflect campus experiences and creative cost-saving strategies. Facilities leaders should use the tactic to jump-start TCO-informed conversations with project stakeholders and choose a handful of tactics to adopt.

The second section focuses on the creation of an action-oriented "Lessons Learned" document. This document captures hard-won lessons during and after capital projects. Institutions can use these documents to apply those lessons and minimize TCO for future projects. The second section details five steps to create a Lessons Learned document and provides an editable template to jump-start it.

Sections

1 Compendium of Design and Construction Tactics

100+ tactics to reduce long-term maintenance costs and minimize total cost of ownership.

2 Strategies for Tracking Design and Construction Lessons Learned

Template and guidance for creating a living "Lessons Learned" document for use during and after capital projects.

Source: EAB interviews and analysis.

Compendium of Design and Construction Tactics

100+ tactics to reduce long-term maintenance and minimize total cost of ownership of capital assets

SECTION 1

Architecture

Tactic	Rationale
Allow for overflow space outside all classrooms equal to or greater than 50% of classroom space. (The immediate corridor qualifies as overflow space.)	Overflow space facilitates the change of occupants and accommodates students waiting to enter a classroom. This extends the life of a building by reducing wear related to crowding.
Consider building orientation when planning large exterior windows or glass features.	Installing glass features in the path of direct sun exposure traps heat in the building and can greatly increase energy costs during hotter seasons. While not every building's orientation can be adjusted, campuses have found energy modeling to be particularly helpful in understanding and planning for this aspect of design.
Consider cost implications of all internal glass features, not just windows.	Even room partitions made of glass can be costly. For example, some unionized staff negotiate different rates for cleaning glass and cleaning walls.
Discourage exposed rooftop equipment.	Rooftop equipment that is exposed to the elements can require more maintenance; it also is more difficult for technicians to reach and can be difficult to access in bad weather. Whenever possible, use a covered solution such as a penthouse. If equipment must be on the rooftop, ensure maintenance staff will have access to power, water, and other supplies to complete their jobs.
Ensure convenient and safe access to any roof features/equipment for maintenance personnel by building a stairway rather than a hatch or ladder.	Without convenient and safe roof access, maintenance is only more difficult (and expensive) to carry out. Stairways may not be possible on all buildings, especially older ones, but they should be used whenever possible.
Ensure custodial closets are big enough for carts, employees, and any necessary storage supplies.	Designing closets that are large enough for custodial staff to safely and securely load and store the cart simplifies custodial work and enables it to be completed more quickly.
Ensure all custodial closet doors swing outward.	An outward door swing maximizes floor storage space in the closet.
Extend classroom partitions through the finished ceiling to the slab.	This reduces noise in classrooms and reduces need for soundproofing.
Include a custodial closet near high-traffic areas in a building.	Installing a dedicated closet near busy areas ensures that custodians can easily access supplies where they are most frequently needed.
Include custodial closets on every floor of a multi-story building.	This eases custodial operations and makes cleaning more efficient by ensuring custodial staff can access supplies throughout the building, rather than having to transport them between floors.
For all frameless glass entrances or wall systems, include a form of visual identification.	Identification helps to prevent people from walking into the glass and can be in the form of etching, graphic decaling, or sandblasting.

Source: EAB interviews and analysis.

Architecture (cont.)

Tactic	Rationale
Include roof walkways for maintenance if the building does not have a flat, walkable roof.	Walkways allow maintenance personnel to access rooftop equipment without walking on the roof, which is not only hazardous but can also damage the roof. Specify the type and location during the design phase and include in drawings.
Install weather-protected entrances in buildings with hardwood floors.	Protected entrances prevent water from entering the building during weather events, which protects wood floors and prolongs their life span.
Locate mechanical rooms so that they can be accessed directly from building exterior.	Exterior entrances allow staff to access mechanical rooms whenever needed, without disturbing occupant activities.
Provide access panels for systems inside ceilings and walls.	Access panels save money and minimize occupant disruption during future maintenance, since maintenance staff can easily access systems without needing to open surfaces.
Provide adequate shelving in custodial closets.	Providing plenty of storage space in closets improves custodial efficiency by ensuring that supplies are always on hand and do not need to be retrieved from elsewhere. It also maximizes the existing custodial space, reducing the need to designate additional locations for supply storage.
Provide depressed, transitional walk-off areas at building entrances.	A walk-off area collects water and dirt, reducing floor covering wear and maintenance.
Position supply and equipment storage rooms near at least one elevator and one loading dock.	Proximate storage rooms reduce the time and effort needed for the transfer of supplies.

Source: EAB interviews and analysis.

Doors and Windows

Tactic	Rationale
Choose manual window shades over electronically operated shades.	Electronically operated shades break easily and are difficult to fix.
Install double-glazed windows.	Double-glazed exterior windows can reduce heat loss by as much as half compared to single-glazed windows.
Install kick plates on doors in high traffic areas or on those that are subject to abuse by equipment associated with building function.	Kick plates extend the life of a door and decrease the need for repairs by protecting the surface from damage.
Insulate exterior doors that open into climate-controlled spaces.	Insulation prevents temperature variance from outside air infiltration. Provide fully weather-stripped doors, including head, jambs, and door bottom seal.
Prohibit mats inside revolving door drums.	Mats do not wear well and will heave, causing the door to eventually bind and warp.
Provide electromechanical hold-open closers with automatic release for fire doors.	Equipping doors with this system makes it easy to keep doors open while still ensuring safety by automatically closing when the fire alarm is triggered. Avoid use of magnetic holders, which may require degaussing and may hold doors open even when electrical current is disconnected.
Replace rope attached to window weights with brass chains in historic buildings.	Rope connected to window weights wears away over time and can cause the windows to become immovable. Mold can also grow on the ropes.
Require weather stripping to be easily replaceable without major disassembly of the door frame.	Easily removeable weather stripping reduces maintenance time and effort.
Tint southern-exposed windows.	Tinting conserves energy by reducing the amount of sunlight that enters the building, without sacrificing natural light or exterior views.
Use awning and hopper windows.	Awning and hopper windows resist wind damage and water penetration better than most other window types, such as casement windows and projecting windows, which are often damaged when exposed to heavy wind loads. Note that swing-in hopper windows sometimes obstruct interior furnishings and sills.
Use entrance mats that are small and light enough to be rolled and moved by one person.	A smaller mat size speeds cleaning and requires fewer maintenance staff to be involved.
Use revolving doors for major building entrances.	Revolving doors save significant energy when used in lieu of traditional swinging doors. Note that an adjacent, ADA-compliant accessible entrance is required in conjunction with revolving doors. Signage promoting energy efficiency can be effective in directing traffic toward revolving doors.
Use tempered glass in doors.	Tempered glass is strong and difficult to break, minimizing replacement costs.

Source: EAB interviews and analysis.

Electrical

Tactic	Rationale
Avoid placing lighting panels in corridors, electrical closets, or janitorial closets. In labs, do not locate panels over lab benches or behind any equipment (movable or fixed).	Avoiding these areas ensures ease of access to panels and saves time for maintenance staff.
Avoid sheen finishes on outdoor lighting fixtures.	A sheen finish wears quickly, necessitating more frequent repainting or refinishing.
Equip rooms with a master light shut-off.	A master shut-off allows building occupants to easily turn off all lighting when rooms are unoccupied.
In colder climates, set outdoor light fixtures back from walkways and driveways to allow for snow removal.	This allows snow to be pushed completely off paths and roadways instead of piling up at the base of lights. Setting the light fixture back also reduces the chance of a plow accidentally damaging a fixture.
Install a dedicated outlet for wet vac, floor dryers, and other electrical equipment in bathrooms.	A dedicated custodial outlet in bathrooms makes cleaning more efficient.
Install an outlet in custodial closets.	A dedicated outlet allows custodial equipment to be charged efficiently and conveniently, while also keeping the equipment safe and out of public view.
Replace all lights with LED lights.	Converting to LEDs requires only a simple switch-out procedure with low up-front cost and clear return on investment.
When selecting a transformer, account for future load growth in its capacity. Design the building's electrical system such that expected actual load profiles fall within specified transformers' peak efficiency ranges as closely as possible.	Following transformer guidelines reduces wear, right-sizes footprint and load capacity, and decreases the need to replace transformers that no longer function appropriately.

Source: EAB interviews and analysis.

Energy and Utilities

Tactic	Rationale
Ensure power and water access is available on any roof with mechanical equipment.	A dedicated power and water supply near rooftop mechanical equipment eases maintenance by ensuring workers can complete their work without needing to create water or power access.
Heat indoor swimming pools with energy from building exhaust air.	Using dehumidification and heat pump technology to transfer energy from building exhaust air into heat for a swimming pool leads to significant energy savings.
Individually meter each building for electricity, gas, and water consumption.	It is impossible to track energy consumption (and thus, to calculate energy savings opportunities) without individual meters.
Install a continuous wire with all piped utility lines.	The wire is used to locate lines in the future without having to dig up the area, saving time and costs.
Install continuous insulation (CI) on exterior walls.	CI stops thermal bridging, so less energy is required for heating and cooling a building. CI is required by ASHRAE 90.1 and the 2015 International Energy Conservation Code.
Install heat recovery equipment.	Heat recovery equipment can greatly reduce the heating and cooling demands of buildings.
Paint roof white in hot climates.	White roofs keep buildings cooler by reflecting sunlight instead of absorbing it, leading to reduced energy use.
Use a sustainable fuel source that can produce heat as well as power (co-generation).	Co-generation requires fewer components and fewer machine rooms, which reduces both construction and operating costs.

Source: EAB interviews and analysis.

Finishes

Tactic	Rationale
Apply mold and mildewcide admixtures when applying fireproofing.	Some fireproofing attracts mold and mildew; preventing this problem at installation avoids future expenses for replacement.
Avoid self-edge laminates.	Due to the exposed seam, self-edge laminates easily chip, peel, or are ripped off, necessitating more frequent replacement.
Avoid strong color schemes on interior furnishings or walls.	Most color schemes become dated quickly; avoiding them in favor of a mostly neutral palette maximizes the life span of décor and finishes.
Avoid using dark or bright paint or materials on exterior surfaces or in places exposed to sunlight.	Sunlight causes colors to fade, reducing the life span of the materials and requiring more frequent replacement.
Avoid using moisture-resistant boards in ceilings.	Moisture-resistant boards sag more than normal gypsum boards and are not intended for horizontal applications where the frame spacing is greater than 12" on-center. Moisture-resistant boards should be specified in minimum thickness of 5/8" to compensate for a lack of strength.
Avoid VCT or other materials that require refinishing under fixed seating in classrooms.	It is difficult to refinish these materials as required, given that installed furniture must be torn out and reinstalled each time, which costs time and money and disrupts occupants.
Choose a dark carpet that will camouflage dirt and stains.	Light-colored carpet will show wear and stains more quickly, requiring frequent cleaning and replacement.
Choose primer and finish paint coats with stain-blocker and mildewcide.	Choosing durable, damage-resistant materials ensures the longevity of the walls and reduces the need for touch-ups and repaints.
Conduct field testing of waterproofing systems after installation and before coverage.	This allows workers to make adjustments before the system becomes inaccessible, avoiding unnecessary disturbances for future maintenance.
Design backsplashes in countertop areas to be at least four inches high.	High backsplashes prevent water damage to walls.
Install terrazzo floors.	Terrazzo is extremely durable, lasts for many years, and is easy to clean.
Limit the number of interior paint colors.	This saves money during installation and simplifies procurement as there are fewer types of paint that must be kept on hand.
Minimize carpet use.	Compared to other types of floors, carpet is expensive, must be cleaned regularly, and requires frequent repair/replacement. Although carpet is the most appropriate choice for some environments, avoid it in areas where food is served or eaten, where water could be present (including basements), in residence halls, in high-traffic areas, or near entrances.

Source: EAB interviews and analysis.

Finishes (cont.)

Tactic	Rationale
Install a waterproofing membrane under terrazzo.	The waterproofing membrane reduces the risk of water damage to the immediate underfloor, as well as to the floors below.
Use impact-resistant wallboard in high-abuse areas.	This extends the longevity of walls and reduces the need for maintenance. Suggested locations include corridors, public spaces, and building entrances.
Use a solid surface material for wet countertop areas.	Plastic laminate easily peels, allowing water damage. Examples of solid surface materials include cast plastic, stone, and stainless steel.
Use a waterproofing layer and install flashing around the edges of drains beneath tile floors that experience significant water exposure.	Waterproofing and flashing prevents water damage to the floor. Possible locations for this intervention include bathrooms, athletic showers, and major food service facilities.
Use mildew-resistant carpets.	These carpets are more durable and do not need as frequent cleaning or replacement.
Use "mottled" colored tiles for main floor areas.	Solid color tiles tend to be less resistant to abrasion and will show wear quicker than a mottled tile.

Source: EAB interviews and analysis.

Furnishings

Tactic	Rationale
Avoid upholstery in classrooms.	Upholstery wears down quickly, prompting more frequent replacement.
Choose classroom writing surfaces (such as tables and desks) that are finished with an uneven grain.	An uneven grain hides marks, extending the life of the asset.
Consider blackboards or glass instead of whiteboards in some classroom settings.	Although not an appropriate solution for every space, blackboards use chalk that is much cheaper and easier to stock than whiteboard markers. Blackboards and glass are also easier to clean.
Consider using furniture and fabrics that follow infection control protocols.	Adapted from the health care industry, furniture and fabrics that are compliant with infection control protocols are durable, easy to clean, antimicrobial, nonporous, and do not include seams or crevices where dirt and bacteria can grow. These features also make them cost-effective, long-lasting choices for university facilities.
Use chromed finish on the base of chairs.	A chromed finish lasts significantly longer than a paint finish due to its resistance to chipping.
Use health care grade fabrics on all upholstered furniture.	Fabrics used for health care settings can be cleaned with bleach, have a high double-rub, and last a long time.

Source: EAB interviews and analysis.

Landscaping

Tactic	Rationale
Align irrigation system spray heads adjacent to parking lot curbs with parking stall striping.	This prevents damage to the irrigation system from vehicles.
Avoid edging materials that can damage mowing equipment or spill into grass.	Certain edging materials, such as loose stones or pebbles, are unlikely to remain in one place and can potentially damage mowing equipment if they get caught in blades.
Avoid female fruit-bearing trees in landscaping.	Fallen fruits will require additional cleanup by grounds staff.
Avoid right angles in landscaping.	Speeds mowing activities, since grounds staff do not have to back up equipment repeatedly to navigate corners.
Avoid seeding new landscape until all surrounding work is complete (e.g., underground water and electrical line work, sanitary and storm sewers, paving, curbs, drainage structures, etc.).	Delaying until surrounding work is complete reduces the chance of needing to dig up the seeded area and then re-seed it.
Consider hardscaping rather than traditional landscaping.	Hardscaping is easier and cheaper to maintain than traditional landscaping.
Test soils before embarking on significant building planning.	Failing to assess the soil on the building site can compromise long-term building stability. Building foundations need to be appropriate to the composition of the soil they rest on, or they may settle unevenly and even collapse. Exterior materials such as waterproofing should also be selected with soil composition in mind to avoid corrosion.
Use monolithic pours when installing curbs and gutters.	Monolithic pours reduce the risk of cracks or chipping, which can result in water damage.
When designing irrigation systems, avoid overspray, spray blockage from adjacent aboveground utilities (e.g., electric transformers, light standards, etc.), and misting from excessive pressure.	Designing irrigation systems with these features conserves water usage and avoids unnecessary costs.

Source: EAB interviews and analysis.

Mechanical

Tactic	Rationale
Avoid fiberglass duct liners.	Even fiberglass duct liners with antimicrobial coatings decrease indoor air quality over time. The surface of the material itself collects dust and dirt and becomes a feeding ground for microbial growth. Duct cleaning also tends to erode the surfaces and edges of the fiberglass, which then starts peeling and flaking into the airstream.
Avoid placing a cooling tower on roof.	Rooftop cooling towers increase the risk of water penetration to assets on lower floors.
Avoid placing HVAC equipment in the ceilings of IT rooms.	HVAC equipment can draw water into a room, possibly damaging IT equipment. Locate the equipment outside the rooms and duct in, or use a split system and hang the evaporator on the wall, draining outside the room.
Avoid routing hydronic piping through electrical or telecom rooms.	This can prevent unnecessary replacement costs due to damage of telecommunication or electrical equipment in the event of a leak.
Ensure all convector cabinets are accessible.	Accessibility eases post-construction servicing.
Install a high-efficiency cooling tower.	High-efficiency cooling towers reduce energy consumption and costs.
Install a Thermal Energy Storage (TES) tank.	A TES tank can save up to 35% in refrigeration consumption.
Install central air instead of packed terminal air conditioner (PTAC) or other individual room cooling solutions.	PTACs require frequent maintenance and use more energy to run than solutions such as chilled water lines. Non-central cooling solutions also fail to provide much circulation of air within the building, which can cause mold.
Install energy-efficient heat pumps.	Energy-efficient heat pumps reduce electricity consumption and lower utilities costs.
Install redundant core infrastructure.	Redundant infrastructure prevents interruption to core building functions such as water, heat, or power in the event a system fails or must be shut down. This is especially important for research facilities and classrooms so that university operations can continue.
Install tether cables for access panels and covers on rooftop mechanical equipment.	Cables prevent loose panels and covers from blowing away when removed for equipment maintenance.

Source: Araner, "Boosting Power & Savings: Unprecedented Results in Thermal Energy Storage," https://www.araner.com/blog/boosting-power-savings-thermal-energy-storage/; EAB interviews and analysis.

Mechanical (cont.)

Tactic	Rationale
Install variable speed drive (VSD) chillers.	VSD chillers can generate up to 30% energy savings as compared to other models.
Insulate steam tunnels and pipes beneath plants and trees.	Insulating steam tunnels and pipes helps to minimize damage to plants from pipe heat, reducing the need for replacement.
Use round ducts wherever feasible.	Round ducts are inherently strong and rigid. Their durability makes them the most appropriate for horizontal exterior ductwork. The round shape also minimizes rain or snow collecting on upper surfaces.
Use premium efficiency motors on pumps and air handling units.	Premium efficiency motors lower energy consumption.
Use variable air volume (VAV) HVAC systems.	VAV systems reduce energy consumption and costs.
Wherever space allows, conservatively upsize ducts.	This reduces pressure drops and allows for future flexibility if increased airflow is required.

Source: York, "Variable Speed Drive Chillers Save Energy," https://www.york.com/for-your-workplace/chilled-water-systems/knowledge-center/variable-speed-drives/variable-speed-drive-chillers-save-energy; EAB interviews and analysis.

Plumbing

Tactic	Rationale
Avoid locating plumbing devices that require preventive maintenance within occupied spaces or above those spaces' suspended ceilings.	Installing plumbing devices in areas with low accessibility complicates maintenance tasks and increases the risk of disruptive flooding.
Ensure all plumbing risers have isolation or sectionalizing valves at each floor level.	These valves allow for localized draining and servicing of the water system, preventing disruptions to other parts of the building if maintenance is needed.
Ensure clean-outs for drainage, sewage, and lab waste piping are readily accessible.	Accessible clean-outs ease future maintenance. Locate clean-outs in common public spaces or utility rooms when possible.
Floor-mount slop sinks in supply and janitorial closets.	Floor mounting prevents spills on the floor and makes it easier to clean and prepare mops and buckets.
Install floor drains in all mechanical rooms.	Drains prevent water damage if equipment leaks.
Place water sources in interior spaces with large quantities of plants.	A proximate location to plants prevents staff from carrying water across large distances.
Locate storm drain catch basins and water sources near trash equipment locations.	Nearby water sources ease cleaning of trash-compacting equipment and reduce odors.
Provide space in lab buildings for future installation of neutralization systems on laboratory waste lines at their connection to the sanitary system.	The space keeps labs flexible for the future without requiring major space renovations.
Use poured material or seamless flooring in bathrooms.	This reduces the risk of water damage and eases future custodial work.
Use steel pipe encasements for water lines under critical roadways, tunnels, and utility duct banks.	Encasements reduce the risk of flooding.

Source: EAB interviews and analysis.

Restrooms

Tactic	Rationale
Avoid placing restroom mirrors adjacent to doors.	Mirrors adjacent to doors are easily broken by impact from door handles or wheelchairs.
Consider designing restrooms without countertops.	Countertops in restrooms are difficult to keep dry, difficult to keep clean, and are easily damaged.
Position soap dispensers above sinks or countertops.	This placement prevents drippings from falling onto the floor, which can create slippery conditions and slow down the cleaning process.
Purchase coreless toilet paper dispensers.	A coreless dispenser reduces mess and limits toilet paper consumption in high-traffic restrooms. It also streamlines the restocking process, as the dispenser can hold more than one roll of paper.
Standardize toilet paper and toilet seat cover dispensers.	Standardization allows for cheaper and more efficient restocking.
Use ceiling-hung partitions in restrooms.	Floor-mounted partitions slow floor cleaning. However, floor-mounted partitions may be necessary in gender-neutral restrooms or those with high ceilings.
Use copper and paint back-coatings on mirrors.	A back-coating protects the silver mirror surface from tarnishing.

Source: EAB interviews and analysis.

Safety and Security

Tactic	Rationale
Avoid installing fire alarm systems requiring special staging or ladders longer than standard stepladders.	Installing less complicated systems eases routine maintenance and testing, especially since accessibility is a primary concern for the location of fire detection devices.
Consider an electronic card reader locking system for all means of exterior egress on campus.	This type of system permits access to be customized for each card holder. Doors can be locked/unlocked remotely, saving money if after-hours lockouts occur. Retaining a metal key system means than an FTE must be on hand for lockouts. However, the cost of installing and maintaining an electronic lock system may be higher than that of a traditional system.
Use a consistent lock make and model across campus.	Standardization eases maintenance tasks and improves safety.
Use revolving door locks with bolts that set horizontally.	Locks with strikes in the floor collect dirt, preventing the door from locking. Floor strikes also require frequent cleaning and maintenance.

Source: EAB interviews and analysis.

Miscellaneous Recommendations

Tactic	Rationale
Conveying Systems	
Install digital controls and variable speed drives on elevators.	When combined with a digital control system, variable speed drives allow for a greater number of rides in the same amount of time while using less power.
Provide mounting clips and removable wall blankets for each elevator.	Providing blankets and a place to hang them ensures that the elevator's interior is protected during moves, also reducing future maintenance.
Require the use of Class C elevators.	Higher-weight capacity elevators stand up to wear and tear better than other classes.
Hardware	
Use tamper-proof fasteners on hardware in easily accessible settings.	Tamper-proof fasteners extend the life of hardware by reducing possibility of vandalism or damage.
IT	
Consider installing additional data drop conduits and back boxes in all rooms.	Additional conduits allow for future flexibility without needing to access the walls.
Masonry	
Avoid water repellents on brick masonry.	Repellants can impact vapor migration and trap moisture, damaging the brick when the trapped water freezes or thaws.
Use stainless steel pins with a copper thimble soldered to flashing to protect against water intrusion.	These types of pins prevent water from entering and resist corrosion.
Metals	
Apply corrosion protection to outdoor steel infrastructure, such as roof decks.	Corrosion protection prevents premature replacements and staining of surrounding materials.
Avoid galvanized steel flashings.	Galvanized steel easily corrodes, requiring earlier replacement than otherwise necessary.
Provide stainless steel screening in all concealed building areas.	Stainless steel resists corrosion and prevents bird, rodent, and insect filtration. Concealed spaces include crawl spaces, attic vents, exterior louvers, and spaces behind casework.

Source: EAB interviews and analysis.

Miscellaneous Recommendations (cont.)

Tactic	Rationale
Roofing	
Avoid rooftop wood screens.	Wood screens are flammable and have additional maintenance issues, such as weather-related wear.
Cover or plug all existing roof openings (drains, vents, air intakes, etc.) at the start of each day during construction; remove covers and plugs at the end of the workday.	This prevents debris or contaminants from entering the building below.
Verify that all roof drain lines are functioning correctly before starting work.	This reduces the risk of costly water damage later.
Transportation and Access	
Add a loading dock to buildings that require regular deliveries of products or will frequently receive large vehicles for maintenance work.	A loading dock saves time and effort and increases safety while loading and unloading materials. A dedicated loading dock and service entrance also separates occupant and Facilities traffic.
Recess or enclose all protruding elements of loading docks where birds could roost. Seal flush all cracks, crevices, and separations between materials.	These precautions prevent the need for regular cleaning due to bird waste.
Walls	
Use wall and corner guards in high-traffic areas.	Wall and corner guards protect walls from damage that commonly occurs in high-traffic areas. They prolong wall life span and reduce the frequency of necessary maintenance.
Waste Disposal	
Use fire-resistant trash receptacles.	This prevents fires in trash receptacles, which can result not only in added costs but also in significant safety risks.
Ensure waste containers and compactors are easily accessible from the building interior at-grade or by ramps. Locate containers so waste can be emptied with a downward motion, not an upward motion.	This eases trash removal and reduces the possibility of waste spillage.

Source: EAB interviews and analysis.

Strategies for Tracking Design and Construction Lessons Learned

Template and corresponding guidance for creating a living "Lessons Learned" document for use during and after capital projects

SECTION 2

Strategies for Tracking Design and Construction Lessons Learned

Facilities leaders have a unique opportunity to influence capital projects—and ideally minimize total cost of ownership—by actively managing design guidelines. Design guidelines should be ever-evolving documents, shaped by expert input, institutional policy, and technological advancements. Experiences with current or past projects should serve as the foundation for many of these updates. However, recording those experiences is sometimes deprioritized in the chaos of building handoff.

To ease knowledge capture, Facilities leaders should create a **"Lessons Learned" document**. This document should capture the hard-won design and construction insights that the project manager and other stakeholders learn during a capital project. The institution can then apply these lessons to future projects. The lessons can also supplement design guidelines as examples of micro-level decisions that are important to share with design and construction partners. Over time, the lessons may be incorporated into design guidelines (as appropriate).

Five Steps for Maximizing the Value of Lessons Learned Documents

1. **Assemble project stakeholders for an in-person debrief session.** Rather than relying on stakeholders to write suggestions via email, project managers or Facilities leaders can capture all lessons learned at once through interactive sessions that also prompt cross-silo thinking and observations.

2. **Specify the rationale behind each lesson learned.** Articulating the larger context verifies that lessons learned are more than just preferences. Recording the date and project associated with each added lesson provides useful context as well, as the document evolves.

3. **Organize lessons by Facilities function.** Grouping allows for quicker review by functional areas.

4. **Save the Lessons Learned in a widely accessible location.** A central location allows all project managers to access and update the document as they complete projects.

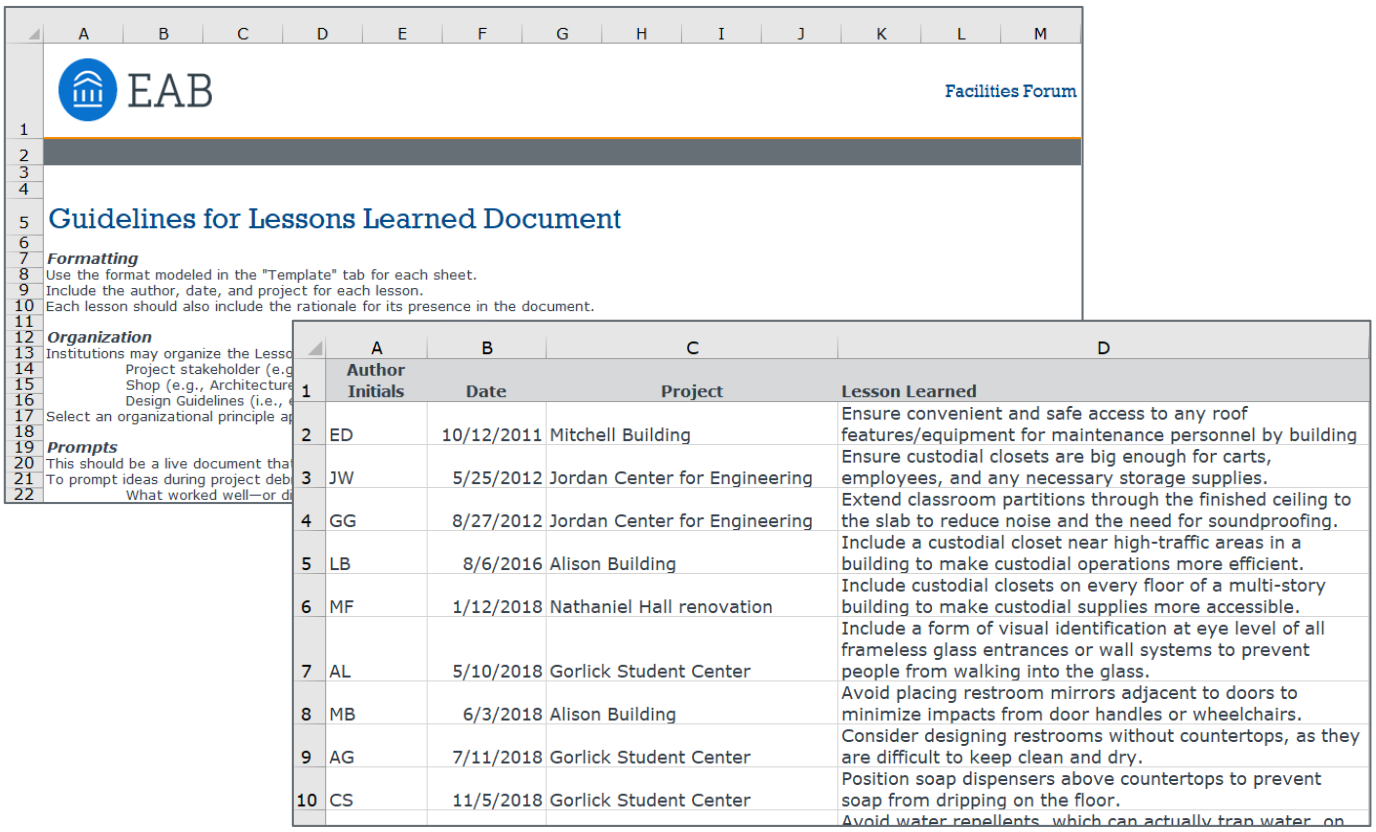
5. **Send the Lessons Learned document to A&E partners before each project as a supplement to the design guidelines.** Although Facilities leaders may eventually incorporate some lessons into the design guidelines, the document can serve as an addendum between major updates.

Source: EAB interviews and analysis.

Lessons Learned Template

To jump-start the adoption of this practice, EAB has created a Lessons Learned template. It includes suggested organizational structures and formatting, as well as prompts for project debrief sessions.

Download the editable template at eab.com/TCOtactics.



EAB

Facilities Forum

Guidelines for Lessons Learned Document

Formatting

Use the format modeled in the "Template" tab for each sheet.
Include the author, date, and project for each lesson.
Each lesson should also include the rationale for its presence in the document.

Organization

Institutions may organize the Lesso
Project stakeholder (e.g
Shop (e.g., Architecture
Design Guidelines (i.e.,
Select an organizational principle ap

Prompts

This should be a live document tha
To prompt ideas during project deb
What worked well—or di

	Author Initials	Date	Project	Lesson Learned
2	ED	10/12/2011	Mitchell Building	Ensure convenient and safe access to any roof features/equipment for maintenance personnel by building
3	JW	5/25/2012	Jordan Center for Engineering	Ensure custodial closets are big enough for carts, employees, and any necessary storage supplies.
4	GG	8/27/2012	Jordan Center for Engineering	Extend classroom partitions through the finished ceiling to the slab to reduce noise and the need for soundproofing.
5	LB	8/6/2016	Alison Building	Include a custodial closet near high-traffic areas in a building to make custodial operations more efficient.
6	MF	1/12/2018	Nathaniel Hall renovation	Include custodial closets on every floor of a multi-story building to make custodial supplies more accessible.
7	AL	5/10/2018	Gorlick Student Center	Include a form of visual identification at eye level of all frameless glass entrances or wall systems to prevent people from walking into the glass.
8	MB	6/3/2018	Alison Building	Avoid placing restroom mirrors adjacent to doors to minimize impacts from door handles or wheelchairs.
9	AG	7/11/2018	Gorlick Student Center	Consider designing restrooms without countertops, as they are difficult to keep clean and dry.
10	CS	11/5/2018	Gorlick Student Center	Position soap dispensers above countertops to prevent soap from dripping on the floor.
				Avoid water repellents, which can actually trap water, on

Source: EAB interviews and analysis.

Exemplar Design Guidelines

This compendium, in conjunction with a Lessons Learned document, can play a supporting role to design guidelines or standards. These guidelines are a critical tool in managing total cost of ownership; consequently, more campuses are looking to modernize and more regularly manage their content. One critical element to consider is how to maximize the utility and accessibility of these documents. The institutions below all have design documents with strengths that are worthy of emulating when considering opportunities to update guidelines on campus.

Exemplar	Strength	
ASU Arizona State University	**CSI Standard**	**Arizona State University** organizes its guidelines according to the 16 divisions of the Construction Services Institute's (CSI) MasterFormat
University of Virginia	**Brevity**	**University of Virginia** trimmed its guidelines from 323 pages to 144 pages including appendices (a 55.4% reduction) for easier reference
MIT	**Symbols and Colors**	**MIT's** Building Systems Design Handbook has used color-coded symbols to indicate different types of standards (e.g., a red cross for health/safety, a blue wrench for operations)
USC University of Southern California	**Accessible Web Format**	**University of Southern California** has a dedicated design guidelines landing page, with embedded links to each section and the date revised clearly displayed
Brown	**Searchable**	**Brown University's** guidelines have a search bar for ease of navigating the document
University of Michigan	**Linked Documents**	**University of Michigan's** design guidelines link to related documents at the beginning of each section, including other sections of the guidelines

Additional Design Guideline Examples

In addition to Facilities Forum member input and the guidelines cited above, the following institutions have design guidelines that informed this compendium. All links are accurate as of September 2019.

- Carnegie Mellon University
- Pennsylvania State University
- Rice University
- Stanford University
- Texas A&M University
- University of Alaska Anchorage
- University of California San Francisco
- University of Colorado Boulder
- University of Toronto
- University of Washington

Source: EAB interviews and analysis.

36897
Cover image: iStock

Washington DC | Richmond | Birmingham | Minneapolis
202.747.1000 | eab.com