Challenges in Adapting Historic Buildings for New Science Teaching and Research

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The creation of vibrant and effective campus STEM facilities today often faces numerous obstacles. Issues of funding, adequate sites, political will, and clarity regarding programmatic and organizational needs can represent significant project challenges. This article assumes that these issues have been addressed and focuses instead on the challenges of fitting new, technically-advanced STEM research and teaching programs into existing buildings. The University of Minnesota Tate Science and Teaching Renovation project served as a fertile testing ground to identify and explore the issues surrounding high-tech retrofits into historic structures. Projects of this type should address the following four key considerations:

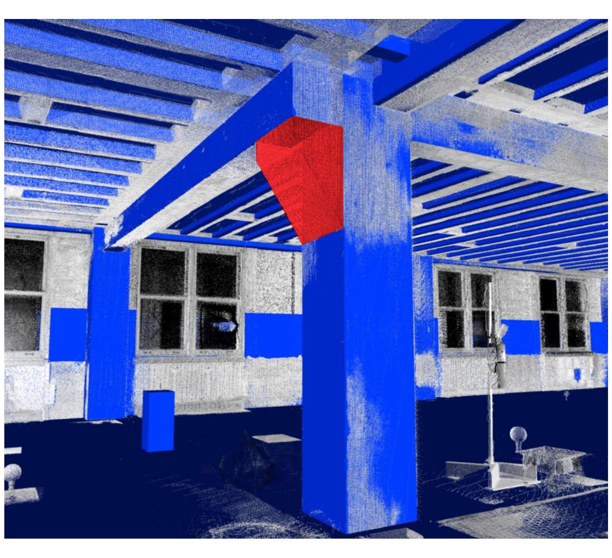
1. Understand Structural Limitations
2. Remove, Replace, and Repurpose
3. Address Building Envelope Deficiencies
4. Integrate Highly Sustainable Building Systems

1. Understand Structural Limitations

At the onset of a renovation, careful attention must be given to understanding the structural capacity and condition of the existing structure. Construction standards and practices have continued to evolve over the years, commonly resulting in a wide range of capacities within the floor, roof, wall and column, and foundation systems. Loading capacities can vary widely within a single building, especially when it has been added to over time. Determining the capacity of a building's structure is best handled by a structural engineer experienced in assessing and modifying historic structures. That stated, a few tools that will help the Design and Owner team understand the structure they must work with include:

- Loading capacity diagrams of the existing columns and floors
- Floor-to-floor height diagrams illustrating clear floor heights
- Floor-level change diagrams to understand accessibility issues
- Laser scans of existing structure to substantiate existing documentation

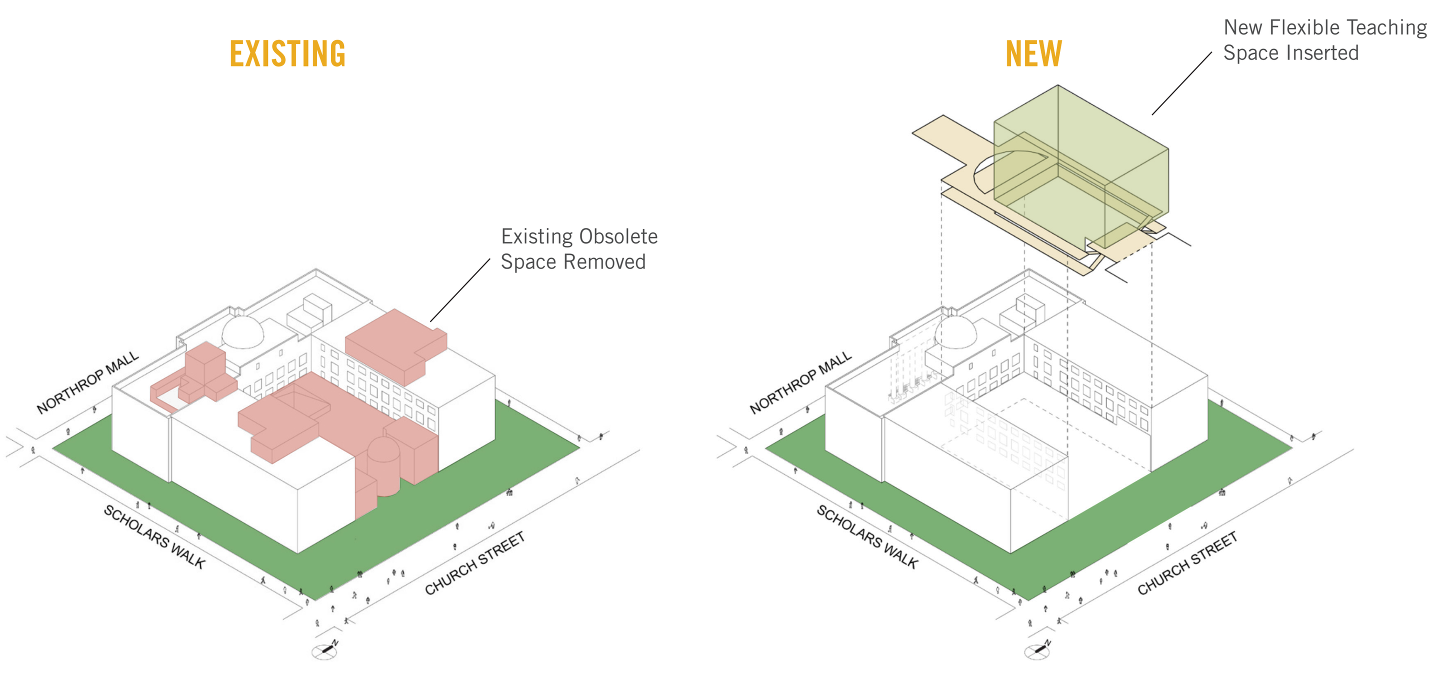
Once a clear understanding of the building's structure is achieved, the team is ready to start assessing how to fit the new program into the existing structure.



2. Remove, Replace, Repurpose

One of the most challenging planning considerations in repurposing historic structures is optimizing the use of the existing structure while achieving the programmatic goals. Common challenges range from achieving ADA compliance and providing accessible routes, locating hallways and corridors to allow adequate space for adjacent program, right-sizing faculty and researcher offices, and meeting current code requirements for exit stairs and discharge. Frequently, obsolete portions of a building will need to be selectively removed to accommodate current and future uses. A good example of this in the Tate Science and Teaching Renovation was the removal of approximately 40,000 SF of poorly utilized space in the center of the building to make room for a 60,000 SF insertion of new construction. The new construction met the flexible clear-span requirements of modern classrooms and provided a new accessible entrance along the former back side of the building.

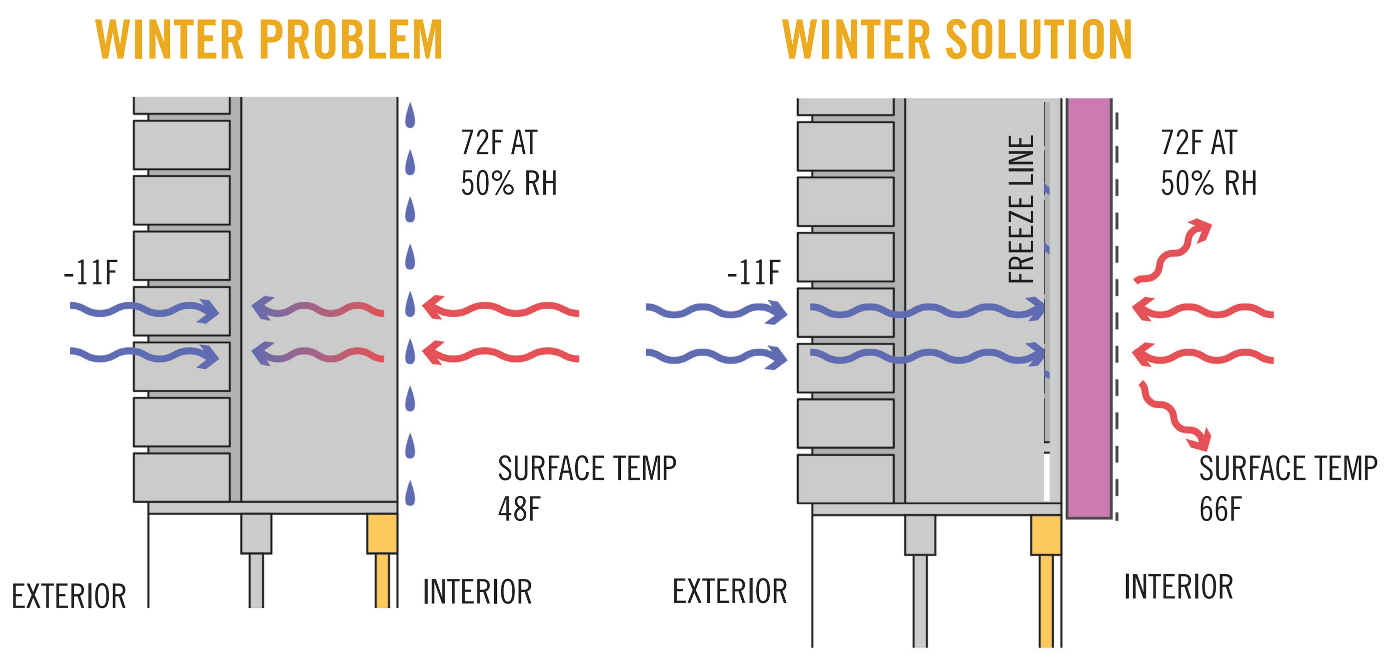
An additional challenge in working with existing buildings is to allow the existing character and identity of the building to shine through, preserving the heritage of the building, while meeting the needs of a new program. This can be achieved in a variety of ways, from identifying and retaining historically significant elements and providing "breathing room" in the design between new and old as well as carefully addressing the connections between the two.



3. Building Envelope Deficiencies

Existing building exteriors play a primary role in maintaining the historic and cultural heritage of a campus. Restoration of some kind is typically needed. Careful attention to window restoration and/or replacement is a frequent consideration. Many buildings constructed before the 1950s had little to no insulation in the exterior walls. Solid masonry construction provided a significant thermal mass, and although performing poorly in terms of vapor transmission and R-value, these walls hold up reasonably well. The challenge is when new uses are planned along the exterior walls, requiring modern standards of climate control and humidification.

Many of the functions in modern academic buildings, especially STEM buildings, require space conditioning that causes condensation on surfaces not previously exposed to moisture. One particularly problematic area to watch out for is at leaky exterior walls and windows, allowing uncontrolled water vapor to enter the building during cooling seasons and posing potential condensation problems on cool interior surfaces (e.g., HVAC diffusers, chilled beams, water lines, and dewars – gas tanks that cool as gas is released). On the other end of the spectrum, during heating seasons, humidified air – especially in labs with high humidification – can condense on windows, exterior wall surfaces, and structure near exterior walls. Neither of these conditions are acceptable and a variety of solutions to remedy the issue are required. This ranges from window replacement and/or storm windows installation, to tuckpointing and sealing up cracks in the exterior, to adding insulation and vapor barriers. Interventions can have significant impact on the thermal and vapor performance of the existing exterior walls. Changes in the vapor and thermal performance can result in unintended negative impacts due to moisture entrapment and impact of the freeze-thaw cycle.



4. Integrate Highly Sustainable Building Systems

STEM buildings are significant energy consumers with programs that frequently require high air changes, large exhaust needs, and with high electrical demands. As in any renovation or new construction, conservation is the best first course of action. When integrating building systems into existing buildings with compromised headroom and/or limited pathways for systems, a variety of strategies should be considered.

- **Maximize use of district utilities** to leverage the efficiency and capacity of campus systems.
- **Implement heat recovery systems** on all air streams to reduce waste energy loss.
- **Minimize ventilation rates** through "smart" building controls, occupancy sensors, and best practices.
- **Decentralize distribution systems** to deliver air and services close to the point of use. Avoiding large shafts, deep ductwork, and long duct runs can increase energy performance and minimize energy loss through high static friction.
- **Decouple heating and cooling loads** from the ventilation system through use of hydronic systems to reduce ductwork and fan energy. Allowing ventilation systems to address air changes and humidification, rather than primarily meeting heating and cooling demands.
- **Leverage commissioning and monitor performance** to ensure the building systems are operating efficiently and as intended.
- **Maximizing daylighting** to reduce energy and promote wellness.

Although every building and program is unique, consideration of these four key issues, will enable STEM buildings to address some of the most significant challenges in the renovation of existing buildings.