FEATURE ARTICLE

Phased Transformations of Academic Buildings

Can't vacate the facility? Renovation in stages can be planned efficiently.

by Roger N. Goldstein, Amanda L. Sanders, and Bernard J. Dooley

When you're renovating a campus building, you're contending with dust, noise, vibration, the risk of budget overruns, relocating occupants, extended timelines, and more. Following best practices of experienced planners can help you to mitigate the most common challenges.

OVERVIEW: WHAT DO WE MEAN BY PHASED RENOVATION?

For purposes of this article, we define a phased renovation as having the following characteristics:

» The entire building will undergo some level of renovation

» The building will be partially occupied during construction, rather than being fully vacated

» Multiple steps (phases) are needed to complete the project, due either to logistics or funding

» Temporary or permanent relocation of occupants and their activities is necessary

While the particulars vary across building types, e.g., labs versus residential versus academic space, the fundamental principles characteristic of phased renovations are fairly consistent. This article draws on more than 30 years of experience planning and designing phased renovations of lab buildings, student residence halls, and general academic facilities.

5 TAKEAWAYS . . .

. . . TO SUCCEED IN PHASED BUILDING RENOVATIONS

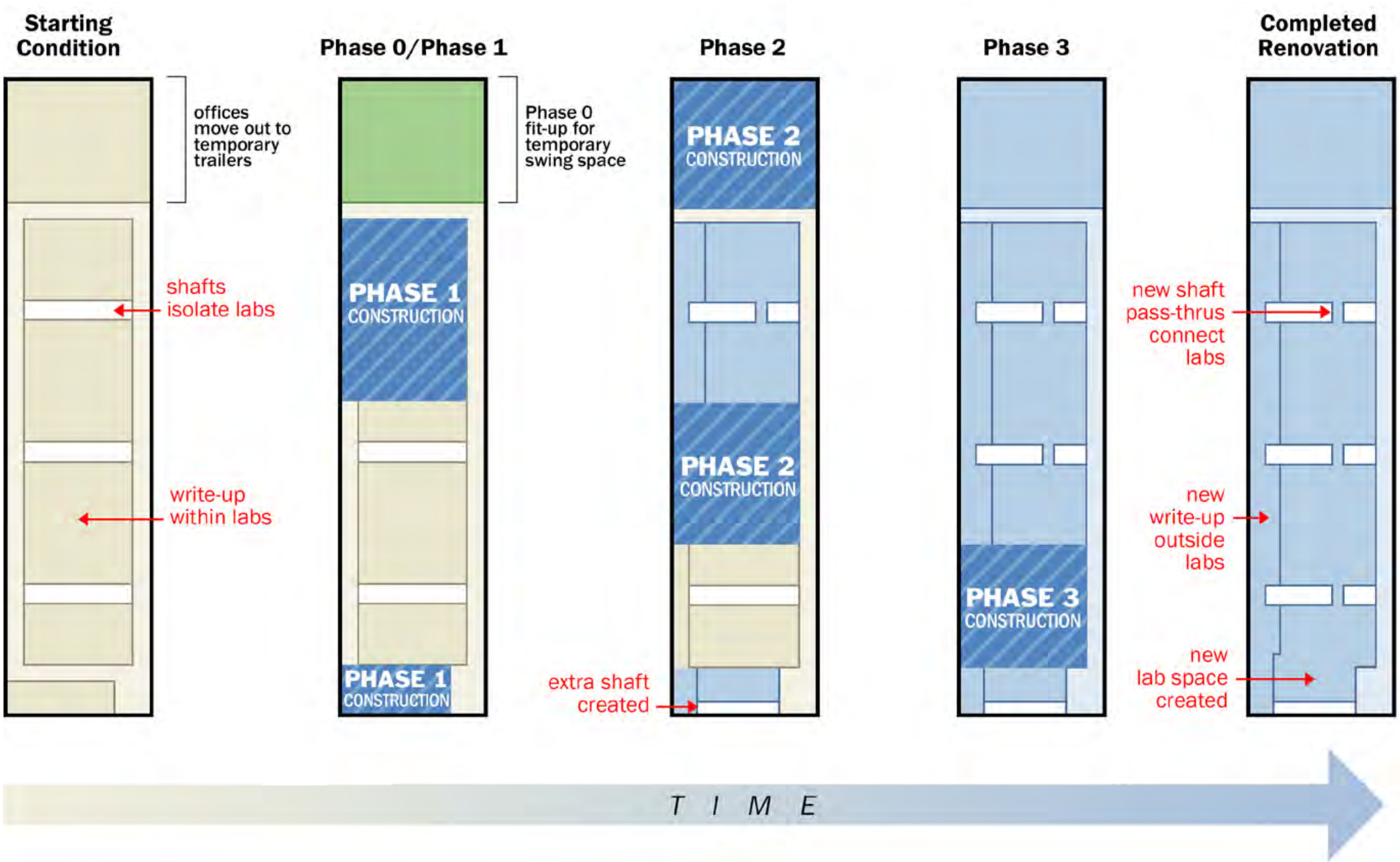
1. When it's needed, **access the right amount of swing space.** It'll become a crucial "threshold issue" for success.
2. **Listen to the building**, regarding structural and systems logic. Doing so will typically drive the design.
3. **Determine where trade-offs may be necessary** to support the phased approach.
4. **Identify early on the realities of disruption and duration.** What will make the renovation survivable with minimum impact on research and instruction?
5. **Develop contingency plans—and budgets—to deal with unexpected events** such as utility interruptions, pauses in funding, and changes in program requirements.

PLANNING WITH YOUR EYES FULLY OPEN

No matter what building type is involved in a phased renovation, it seems unavoidable that a so-called "enabling" phase—sometimes referred to as Phase 0—is necessary prior to the start of the actual restoration of program space. Such enabling tasks can include relocating occupants or equipment to create space ready for renovation, installing systems infrastructure (whether temporary or permanent), building-out swing space to receive relocated occupants, creating new shafts or utility spaces, developing new vertical circulation to facilitate egress during construction, and the like.

As a specific example, the phased renovation of MIT's Dreyfus Chemistry Laboratories required an enabling phase. In order to create sufficient internal swing space to enable vertical phases of renovation, some of the occupants needed to be relocated within the building; others had their space reduced. And the departmental suite and faculty offices were moved out into external swing space. The final step in that enabling work was the temporary conversion of "dry" space to "wet" space to accommodate lab relocations. Figure 1 illustrates how that phase fit into the overall sequence of work.

Figure 1



Phase 0 of the MIT Dreyfus Chemistry Labs renovation involved conversion of office space to "damp" swing space for selected lab support functions. Subsequent phases were vertical slices, centered on each vertical utility shaft. Image courtesy of Goody Clancy.

Given the reality that construction is going to result in dust, vibration, noise, and disruption of activities and movement through the facility, building owners should invest effort in giving occupants plenty of advance information in order to properly calibrate their expectations about the construction phases. That communication can include town-hall-type forums in which design and construction intentions are presented and discussed, email blasts, FAQ documents, and project websites.

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Depending on the building type being renovated, you should measure pre-construction baseline metrics for the building's behavior, particularly regarding vibration and noise levels. That will give you a point of reference for comparison with the data from any ongoing monitoring you will be doing during construction. A valuable step that can build goodwill and understanding among the building occupants is an early presentation by the design team, including the acoustical consultant, to summarize the anticipated vibration and noise due to construction, potential mitigation, and how it will vary by location and distance.

IT DON'T MEAN A THING IF IT AIN'T GOT THAT SWING (SPACE)

The provision of swing space (also called "surge space") may be the single most significant determinant of an efficient phased renovation. The more space you can vacate at a time, the larger the construction area can be for each phase. That has the further benefit of potentially reducing the number of phases, their overall duration, and, therefore, the cost. In other words, the renovation of fewer, larger phases will take less time and cost less than renovating more, smaller phases, all else being equal.

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Broadly, swing space can be *internal*; that is, within the building being renovated; or *external*, that is, elsewhere. In many projects, a combination of both types turns out to be the strategy that works. In some cases, the most appropriate strategy is to move a set of occupants (e.g., faculty offices) out of the building for the duration of the project rather than for just one phase, which helps isolate them from the disruption of living within an ongoing construction project.

To achieve optimal efficiency, you want to create a critical mass of contiguous space to be renovated at one time, to facilitate the infrastructure work and achieve some measure of economy of scale. In a building with scattered underutilized or vacant spaces, you will want to first aggregate those empty areas by relocating functions. That can be done by compressing the space occupied or by relocating occupants (within the building or outside).

Swing space that is suitable for the program that has been identified in other campus buildings is likely to be preferable to paying for temporary external space such as trailers. While the cost of fitting-out that space may be similar to the cost of fitting-out a rented trailer, it's a permanent campus facility asset. The swing space should be located as near as possible to the building to facilitate the occupants' ability to stay in close communication with their colleagues who remain in the building during a given phase. That will be an important consideration, particularly if a function is to be out of its home location for a year or more.

Major renovation projects present the owner with the opportunity to consider whether all occupants of a building should actually be there long term, i.e., should some functions move out permanently? That becomes a fairly simple way to open up space for swing purposes and renovation, creating room to grow the core programs that remain in (or return to) the building.

The preparation of swing space to receive the programs you relocate would be its own enabling-phase task. In advance of actually occupying swing space—whether internal or external—you should allow sufficient time for design and fit-out construction. If you are procuring trailers for swing space, you need to allow time to prepare the site, bring utilities to it, install foundations, and complete any associated sitework before the trailers arrive.

The cost of creating swing space becomes an important component of a project's overall cost profile. It is worth evaluating the tradeoffs between renting trailers and purchasing them outright, as the cost curves will cross a few years out, after which owning may be preferable. Owners should also consider whether, after the project is complete, the trailers can be of use for other campus swing-space needs, further justifying a purchase scenario. At the MIT project cited, the owner decided to retain the trailers for several more years to support other nearby renovation projects.

REDUCING UNCERTAINTY: EXPLORATION AND THE BUDGET

Renovations inherently involve some measure of uncertainty due to the nature of existing buildings. Even with what one believes to be a set of record drawings and specs, you can't know precisely where the conduits and pipes are within a wall, or whether the contractor actually built the structure the way the drawings illustrate. Add to those characteristics the fact that the building might date from the eighteenth-, nineteenth-, or twentieth-century and that changes likely accrued over time without adequate documentation.

It's fine to start with so-called "as-built" (record) drawings, but don't stop there. Because of all of the items previously mentioned, owners and architects need to invest significant effort into field verification and some amount of destructive or non-destructive exploration. The goal is to reduce uncertainty and, therefore, cost (and possibly schedule) risk. One particularly useful technique is an early construction mockup of exterior wall reconstruction; that is an opportunity to evaluate existing conditions and alternative methods of construction, such as wall repair and window replacement approaches.

Phasing premiums can range from 2 percent to 5 percent, depending on where in their budget the owner chooses to carry swing space and enabling costs. Those premiums include the inefficiency of having to keep part of the building occupied—and served by systems—while other areas are renovated. Additionally, related to the premium, there might be restricted access, smaller individual contracts for each trade, multiple mobilizations and demobilizations, and provision of temporary services.

All construction budgeting includes contingencies of various sorts. Renovation generally carries higher contingencies than new construction due to the risk of hidden conditions. Phased renovation deserves an even higher level of contingency because the downstream consequences to schedule and budget for discovering a concealed condition are often greater than a non-phased project.

Construction cost escalation is a significant factor in budgeting for phased renovations. For large, multi-year phased projects, escalation will make later phases cost more, due to the compounded effect of several years of escalation. For example, the escalation cost in years eight to ten of a large, complex 10-year project could end up being nearly as much as the cost of the work in that phase. The best way to mitigate the impact of escalation is to reduce the number of phases and increase the amount of work performed earlier in the project; you'll get more for your investment as a result. Of course, the realities of funding availability may simply make front-end loading of the project scope infeasible.

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DESIGNING A PHASED RENOVATION

When designing a phased renovation, it is often tempting to start by trying to figure out the phasing ("how"), but you should resist that, at least until you have developed a plan for the desired end-state of the renovation ("what" or "why"). While the mechanics of phasing might, in fact, influence aspects of the design, experience has taught us that figuring out the optimized end-state plan should come first. Then you can determine the interim steps that will deliver the most cost-effective result.

A guiding principle we typically use in designing renovations is the idea of "listening to the building." The building's structural pattern, floor-to-floor height, shaft locations, dimensions, distribution of primary systems components, and circulation will logically drive the design. When you add the fourth dimension—time—for a phased renovation, the principle still applies but is modified by an additional layer of complexity. For example, the need to simultaneously maintain building systems in operation, combined with the insertion of new systems, might require the provision of temporary services for which space needs to be found.

Most occupants in a phased project prefer to move the least possible number of times—ideally, only once, from their current location to their final location (which might be elsewhere in the building). While that is desirable from a disruption minimization standpoint, it can be difficult to achieve. Depending in large measure on the availability and quantity of swing space, it is very likely that a given function or occupant might have to move twice: once into temporary quarters, and then a second time, to their final location. Owners and design teams should convey the reality of that situation early in the project, as part of managing expectations. Figure 2 illustrates the multiple moves needed to accommodate the phased renovation of the MIT Dreyfus Labs project.

In addition to keeping track of where each occupant needs to be in each phase is the need to track their equipment and possessions. In the case of science building renovations, that can become a significant task due to the unique service requirements of scientific apparatus and equipment. Many specialized items such as microscopes are not only highly sensitive (to vibration and dust) but also require the participation of the manufacturer whenever equipment is moved and reinstalled, as specific environmental conditions and recalibration are often required.

There are many approaches to the development of design and construction documents for phased renovations. One approach is to develop the full design through construction documents, for the entire project at once, before construction starts. That might be most appropriate for projects with only two or three phases, and for simpler academic building types such as residential buildings. Phased construction presents the opportunity for phased design; the team can learn from a first phase and apply that understanding to the documentation for the subsequent phase.

An alternative, incremental approach is to carry the entire project partway through design—say, schematic design—then proceed into design development, construction documents, and construction administration, one phase at a time. While Phase 1 is under construction, Phase 2 can move into DD, and so on. That approach can help the owner coordinate the design and construction effort with the pace of incremental funding availability. It can also make sense in jurisdictions—particularly in the public sector—in which procurement regulations require individual phases to be bid separately.

Figure 2

Lab and Office Occupancy Sequence

Diagrams at right illustrate abstract cross-section through Building 18, looking east, representing space occupancy. Not drawn to scale.

Legend

- One lab unit: Existing labs contain up to 8 hoods (7 typical), each 5 feet long. Renovated labs contain up to 6 hoods (typical), each 7 feet long. (Support unit labeled in parentheses)
- / Partial unit occupancy
- office
- unavailable (mechanical or under renovation)
- A Faculty 1
- B Faculty 2
- D Faculty 3
- F Faculty 4
- R Faculty 5
- J Faculty 6
- K Faculty 7
- L Faculty 8
- M Faculty 9
- H Faculty 10
- C Faculty 11 (new)
- G Faculty 12
- T Faculty 13
- W Faculty 14
- vf visiting faculty
- HQ Department Headquarters
- s secretary
- (S) shared dry lab support
- N Norris Room
- X vacant

Numbers in italics refer to notes listed below

Notes

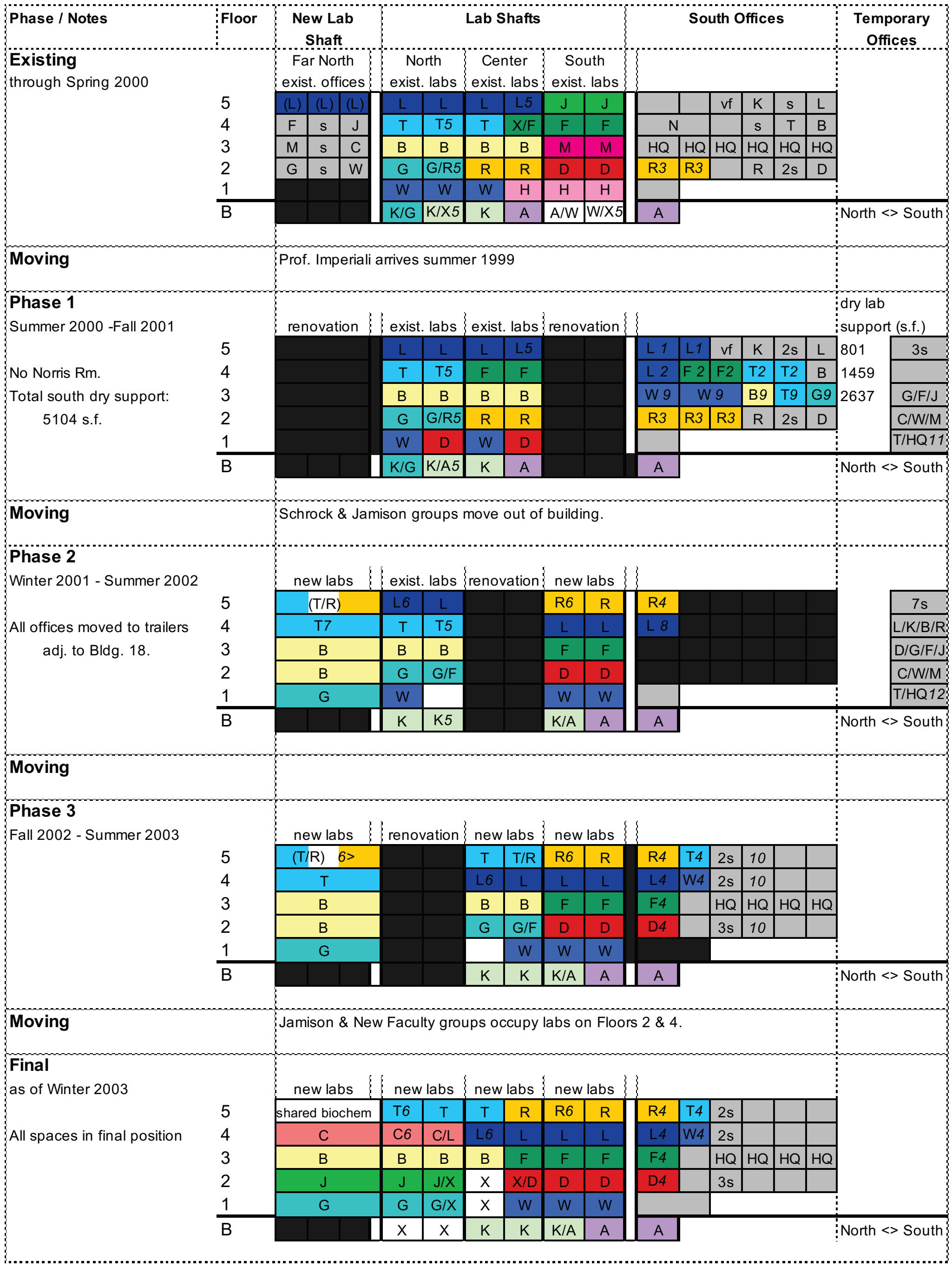
1 Dry lab support in former student study room.

2 New X-ray lab and temporary dry lab support in former Norris, computer & file rooms, Stubbe office.

3 Imperiali lab & computer space in former conference rm. & offices. Break room shared w/ Danheiser.

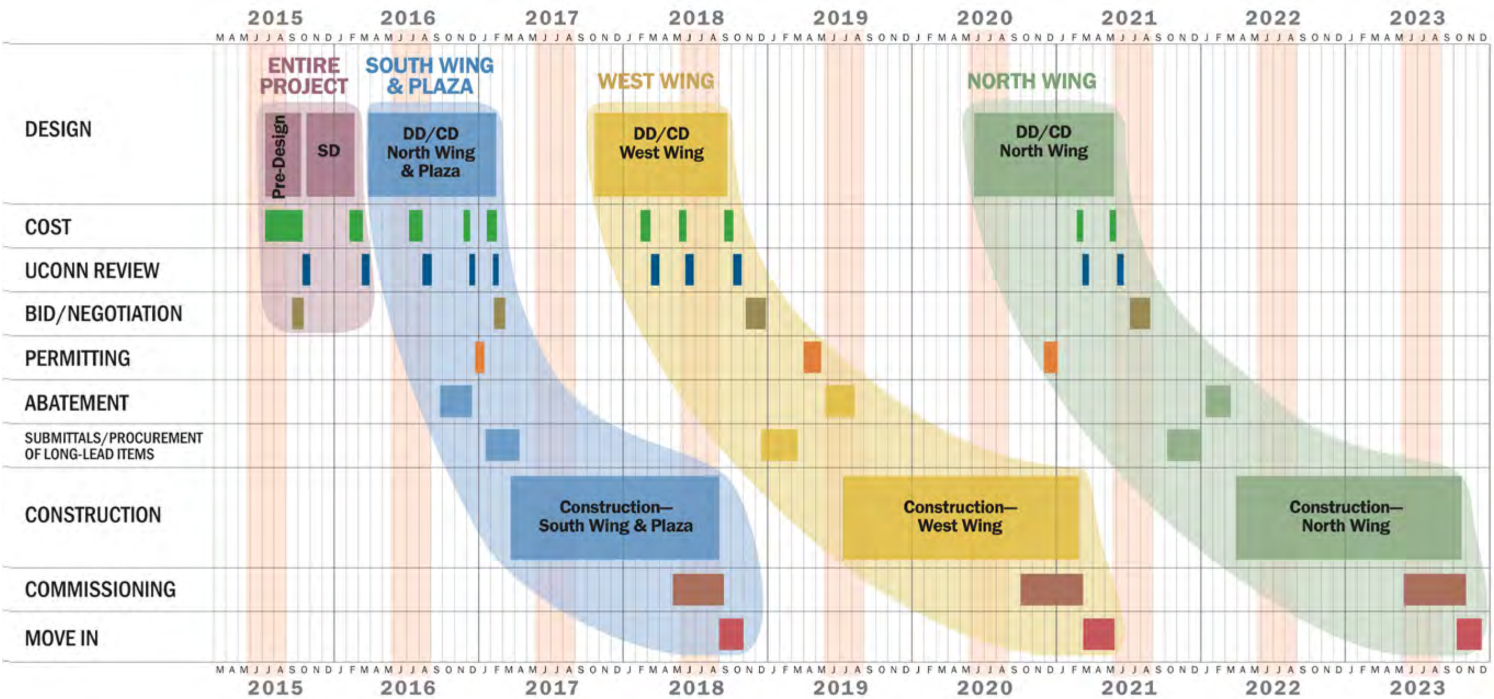
4 Computer room (& X-ray lab for Lippard).

5 Existing cold room in lab bay.



This figure illustrates, through a series of building sections at the MIT Dreyfus Labs project, where each principal investigator would move in each phase. It also tracks key equipment items (e.g., fume hoods or glove boxes).

Figure 3



The UConn Gant Science Complex renovation was designed sequentially, in phases, after an initial schematic design was developed that defined the entire project's scope. It was driven primarily by funding availability, and also allowed some flexibility for later phases to accommodate program changes.

A current ongoing phased renovation of a 1970s science complex provides a good example of the latter approach. The 290,000-gross-square-feet Gant Science Complex at the University of Connecticut (UConn) is currently completing Phase 1 of a three-phase construction process. From the outset of design, the owner envisioned the incremental process previously described, driven by the anticipated funding cycles of the State of Connecticut. That approach has played out as planned, and has proven to have an additional benefit. The pauses between design phases have not only facilitated incorporation of lessons learned, but have given UConn and the design team the opportunity to adjust the design of later phases. Adjustments would allow program change requirements to be captured—e.g., new faculty hires, different equipment, and shifting academic priorities—with less impact to the design work already completed.

CONSTRUCTION PHASE: ANTICIPATING AND COMMUNICATING

The construction phase of a partially-occupied renovation is more complex than a renovation of an empty building. Not only do the workers need to be mindful of the presence of building occupants (and vice versa), but keeping systems in operation while new systems are threaded through the building adds its own challenges.

Immediately prior to construction, as previously noted, we recommend that baseline metrics be established for noise and vibration levels in the building. It is prudent to engage a testing company to take ongoing measurements of such environmental criteria during construction.

Experience has taught us that there are several primary categories of issues that will help determine success.

COMMUNICATION

Both the owner and the construction manager need to be communicating regularly with building occupants to keep them apprised of upcoming construction activities—particularly those that are noisy, vibration-causing, or otherwise disruptive. Utility shutdowns should be scheduled well in advance, and occupants need to know that during a defined period of time they will lose power, water, or other services.

Contingency planning is imperative. For critical life-safety systems, you might even have a Plan B and a Plan C. Envision a set of worst-case scenarios regarding system failures, emergencies, and delayed system switchovers. For buildings housing sensitive research activities or animals, the risks are particularly high, so be sure you have plans in place. For less-sensitive occupancies, the risks may be fewer but need equivalent attention. For critical systems that must remain in operation, a separate set of documents can be prepared to clearly delineate processes and sequences needed to protect those systems on a continuing basis.

The corollary to that concept is the need for a very clear communications chain. For example, if a pipe bursts overnight, whom should the occupants call first: The CM? Someone in Facilities? And the rest of the protocol needs to be clearly defined for everyone's benefit.

EGRESS

Construction workers might be sharing corridors, stairs, and possibly elevators with building occupants. Owners and CMs need to define which party takes responsibility for maintaining safety, including accessibility, egress, lighting, and the like. In other words: Who owns the stairs?

SAFETY AND SECURITY

Establishing and maintaining safe egress during construction is frequently its own mini-project. In some cases, temporary stairs need to be provided in order to deal with an existing stairway being taken over for renovation. Similarly, temporary rated partitions might need to be built to create a code-compliant access corridor or horizontal exit.

A related topic is that occupants need to feel safe within a construction site, both for their personal safety and for the security of their possessions. It may be necessary for the owner to implement additional security measures, physical and/or operational, for the construction phase.

CLOSEOUT

The fact that different parts of the building will be completed and turned over to the owner at different times presents its own challenges. First, staggered warrantees need to be anticipated and managed appropriately to avoid overlap or gaps in coverage. Second, you need to keep in mind that construction activities of later phases should not overlap with zones already completed, so that areas reoccupied by the owner are not subject to damage.

CLOSING THE FEEDBACK LOOP: LESSONS LEARNED

One of the more interesting aspects of multi-phase renovations is the ability to learn from the early phases and apply those lessons to later phases. Sometimes those lessons take the form of construction issues whose resolution can be improved on from one phase to the next. Other situations facilitate feedback from construction into design.

The kinds of lessons that tend to accrue during the projects can be technical, logistical, procedural, or involve constructability and design efficacy. Potentially, all members of the project team—owner, architect, engineer, contractor—can benefit from the lessons-learned cycle. Some lessons will benefit only one of the primary parties. But it is always worth making note of those lessons as they occur—and then bringing them back to the group at the transition into the next phase, or at the earliest opportunity to improve future work.

Renovation (whether phased or not) provides the opportunity to "hit the reset button" and modify occupants' habits regarding the use of the building, with the goal being to help maintain the structure's ability to serve the institution for the long term. Those habits or protocols could range from safety and fume hood management in lab buildings, to deploying a new system for dealing with recyclables or storage, to simply adjusting to a new layout and program distribution that affects movement patterns and access to faculty members.

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ENGAGE WITH THE AUTHORS

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