100-Year Buildings, 10-Year Interiors

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100-YEAR BUILDINGS, 10-YEAR INTERIORS

Summary

Buildings can last indefinitely. The challenge is to make handsome buildings that grace their site, are cost effective, economical to maintain and, most important, adaptable to changing requirements.

Adaptability is crucial to protecting a building investment. Many sound buildings become obsolete because they have permanent but inflexible interior systems. Although a building's shell may be unchanged for a century or more, functional requirements will surely change. Indeed, the ideal would be a building that could adapt to every functional change of its occupants.

Permanent exterior shells with traditional materials need not be prohibitively expensive; modern shop assembly techniques can lower cost. Interior systems need not be flimsy; many high quality components facilitate change and reuse.

Optimizing the design of a useful and lasting building must rely on guesses about the future. However, the important issues for protecting building investments are clear. They are the durability of the shell and some of the permanent interior systems, adaptability to future requirements, compatibility with the context and affordability.

The challenge

Buildings are expensive. It makes economic sense to keep them and amortize their cost over a long time. Moreover, many institutions want buildings that convey a sense of permanency.

But the functional needs change with constant advances in technology and unanticipated requirements. We usually modify our buildings long before they reach the end of their useful life.

The challenge for a new building is to choose which systems will be permanent, which will change and then to choose the right investment for each.

Durability: reality and perception

To convey a concept of permanence, it's been common to refer to a "100-year building." It's useful code for describing durability. It evokes images of ageless building systems (like masonry) and some undefined notion of quality. However, it doesn't carry useful meaning for disciplined analysis or design guidance.

We simply don't know how long a building can last. Two of the oldest buildings in America are a wood frame stucco residence in St. Augustine, Florida, and an adobe residence in Santa Fe, New Mexico. Nine-hundred-year-old wooden Stave churches remain standing in Norway.[1] Some of the original bricks at Babylon are still there (although they were underground for an eon).

Wooden Stave churches have lasted a millennium because the law required failing systems to be maintained.

"If a man builds a church, he must always keep it in good shape and never abandon the site. But if the church decays and the columns start to fall, he must bring new within twelve months; and if he fails in doing so, he will be fined three Mark for his failure and still have to bring the timber and do the repair anyway.

Copied from the Gulating Law written in the 11th century.

The variable life cycle of building systems

Walt Whitman wrote a poem about a deacon who designed a carriage so that nothing *("hub, tire, felloe, crossbar, or floor")* would wear out before anything else.

> *Have you heard of the wonderful one-horse shay,*
> *That was built in such a logical way*
> *It ran a hundred years to a day,*
> *And then, of a sudden, it—ah but stay,*

It's a long poem[2] but the shay (whatever that is) remains unflawed without maintenance until it falls in a heap of dust in 100 years.

Unlike the Deacon, we haven't figured out how to design a building that exists in a state of perfection and then falls in a heap of dust. Building

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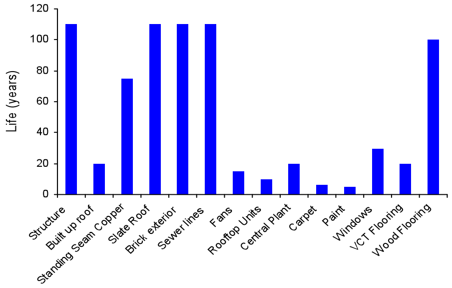
[1] The first generation Stave didn't stand for more than a century. They succumbed to the #1 enemy of durability: water. However, the builders introduced sills, raising the staves (vertical planks) above ground that protected them form moisture and rot. The method worked. Churches built in the 12th century still stand today.

2. If you're interested, you can find the entire poem at http://www.readbookonline.net

systems deteriorate on different schedules; some survive indefinitely, others only a few years. For instance:

1. A structure—wood, steel or concrete—is practically timeless unless water rots the wood, rusts the steel or repeatedly soaks and then freezes in the surface of concrete or masonry.
2. A built-up roof may last 20 years, standing-seam copper 75, slate for centuries, but all will fail if flashing leaks.
3. Brick, and most masonry skins, will need re-pointing or re-caulking at least once, perhaps twice, in a century. But if water gets behind the skin and rusts the ties, the wall will fail.
4. Components of an MEP system degrade in pieces—sewer lines may be virtually ageless; fan motors may have 15-year lives.
5. Carpet, paint and other finishes rarely last a decade.



The useful life of any particular building system is probably as varied as the life of a human—but the chart above is a rough sign of the extreme differences.

We often replace building components that are still useful because there is something better. In the last three decades, owners have replaced many adequate HVAC and lighting systems with more energy-efficient components. In a laboratory or an office building changing requirements demand the frequent destruction and reconstruction of walls and cabinetwork and the rearrangement of MEP systems.

So the task is to know what will change and what will not.

Typically, the shell and structure can be permanent. We can choose low-maintenance systems that express values of permanency. But once we enter the building, all bets are off. We must rearrange partitions and change our MEP systems when the functional requirements change.

Herzstein Hall, on the mall at Rice University, has housed physics labs for nearly a century. High quality but inflexible interior systems make adaptation to 21st century requirements expensive and marginal. The building will eventually house administrative space, but it is likely to be there for the 22nd century

Adaptability: changing function and technology

While a shell may be permanent and durable, the interiors should be flexible. Today the need for information technology puts demands on our buildings that no one anticipated in 1980. What will we need to build for in 2020?

For some building types change is not an issue. Buildings that last for centuries may do so because their functions don't change—the Stave churches have always been churches. The functional requirements remained, people maintained them, and the buildings are still there.

Most buildings aren't so lucky. An office building or a high-tech lab may have to respond to change every few years, long before its interior systems that we replace have reached their useful life.

Pre-WWII buildings are often in better shape than more modern ones. Their terrazzo floors, tile partitions and brick walls have resisted abuse better than the curtain wall, metal stud and drywall construction used in the last four decades of the 20th century. The sealants and adhesives to keep the water out have proved less lasting than the geometrical methods of overhangs and "down and out" material joinery.

But inflexibility is a problem with the older buildings. Paradoxically, many durable buildings become less useful *because* of inflexible interior systems: load-bearing interior masonry walls, inaccessible mechanical systems or small floor plates designed for natural ventilation that make space planning difficult. The building is sound—it just won't adapt.

The point is not to minimize investment by using flimsy building systems for interiors. It is to use flexible systems. Advances in technology and the frequent changes of staff require interior changes in institutional buildings just as they do in commercial office buildings. And high-tech facilities that house research and healthcare are modified every few years. Bringing flexibility, quality and life cycle cost into sharp focus is a good idea.

Planning for flexibility starts with humility. It requires little study of older institutional buildings to realize how often previous generations thought the world would evolve as predicted. While some old buildings are wonderfully useful today, we grieve at well-built facilities that simply don't work—and grieve at the arrogance of earlier generations of architects and administrators who thought they could predict the needs of the future.

And then we make the same mistake. Humility—the simple understanding that we can't see far into the future—is the first prerequisite for good design.

We are not sure what we will need to accommodate future requirements, but there are basic principles of flexibility that we can consider and use to guide design.

Large floor plates, large spans

If a wall is structural, it's impractical to move it. If it contains plumbing or other building services, it's expensive to change.

Frequent interior columns make inefficient space planning and limit the ability to provide large rooms. If space planners must avoid existing columns, the floor plans are constrained and the room layout will not fit the program requirements efficiently. Large floor plates with long structural spans provide greater flexibility. Plan efficiency more than compensates for the small cost premium for long spans.

Accessible building services: modular stub outs and/or space for future distribution

There are two schools of thought: roughing in building services (power, communication, data and other utilities) on a modular basis to every location that might possibly need it or simply providing access space so that any service can be delivered to any likely location.

The argument for the former is that the unit cost is cheaper during initial construction. The argument for the latter is that some access points may never be used and the cost, no matter how cheap, is needless. Furthermore, we don't know what services may be needed in the future. Some may not be invented yet (who would have predicted the miles of fiber optic and cat 5 cable in 1975). Interstitial space, dropped ceilings or raised floor HVAC systems strengthen the argument for the latter.

Adequate ceiling height

Ceilings that are 9½-10 feet high carry little cost premium but provide a large advantage in flexibility for the future possibility of large rooms and tall equipment. They also do a better job of capturing the significant advantages of pendant-mounted indirect lighting.

Consistent modular ceilings

There is often a needless cost to reorganize ceiling systems when partitions are moved. However, if ceiling/lighting systems are modular, and the module is consistent throughout the entire floor plate, that cost is minimized. The partitions should normally pierce the ceiling system and continue to the structure above to minimize sound transfer, but if the ceiling has a consistent module on both sides of the partition, only the part of the ceiling that is pierced will need replacement.

Renovation and remodeling speed

Typically, the operational cost (the staff, utilities, maintenance and supplies) that a building houses, cost 10 to 20 times more than the cost of amortizing construction. Owners lose the use of their building (or at least part of it) during construction. The value of the lost use is an order of magnitude more costly than the construction cost. Therefore, systems that are fast to change are an economic advantage over slower systems.

Planning and the esthetics of context

Good planning protects building investments.

It appears to us that the most common reason to demolish a building is not that it wears out but that its site is needed for something else. America's cities are studded with serviceable, unwanted buildings that remain until the land is needed for a new building and the money is available.

The Thurgood Marshall Building on Capitol Hill houses the offices of the Federal Court System. It sits beside Daniel Burnham's Union Station built almost a century earlier. The Architect of the Capitol set design standards for the shell to be compatible with the Capitol Hill Master Plan. The fenestration patterns reflect Union Station. But the interior systems are GSA office building standards. The shell is a monument to democracy. The interiors are flexible, inexpensive office space.

In urban environments, increasing land values require larger buildings to spread land costs across more useable square feet. Similarly, a land-locked institutional campus may need to increase its density. Academic or athletic areas may need to expand and displace other facilities. If changing land use requires a larger building or a different function, and if a building is not expandable or adaptable, it will be discarded, no matter how well maintained.

So if changing land use is the most common reason to scrap a building the first line of defense is to save building investments is good planning.

Buildings that endure fit a master plan and grace the environment. They engage plazas, malls and circulation paths. They are compatible with adjacent buildings, with their scale, materials, fenestration, decoration, color, structure, orientation and many other macro-design considerations. The building is part of its environment. A building that doesn't fit its context is more likely to be discarded. Its investment is lost.

> *We require from buildings, as from men, two kinds of goodness: first, the doing their practical duty well: then that they be graceful and pleasing in doing it; which last is itself another form of duty. -John Ruskin*

The perception of exterior permanency is as important as the need for interior flexibility. Traditional materials of brick and stone give the impression of permanency. Moreover, they are often consistent with the traditional American campus esthetics. However, they are typically expensive because the labor cost of construction is high and they are slow to erect.

For traditional campuses and institutional owners, the trick is to use 21st century construction technology to provide cost-effective architectural shells that evoke traditional images consistent with a campus heritage.

Affordability: first and life cycle

If buildings last a long time, their annual cost is less. Reducing operating cost is even more important. The costs of maintenance, capital renewal, remodeling and energy are apt to exceed the first cost within little more than a decade.

But there's never enough money. While architects and engineers are interested in designing lasting buildings, educators understandably want to build more space and equip it better. A premium for low maintenance systems loses to the expediency of minimizing first cost.

So we must find cost-effective ways to design handsome, durable, flexible buildings without a large premium.

Care and a design that protects a building from the ravages of water will determine whether a building withstands the onslaught of weather and use. But—and this is the issue for architects, engineers and owners to grapple with—the materials and their configuration have an *enormous* effect on the cost of "care": the cost of maintenance and capital renewal. That's the issue for rational analysis.

When to demolish, when to renovate

It's almost always cheaper to renovate a building than to build a new building because much of the facility can be reused. There are few examples where high-maintenance building systems or continued inattention to maintenance and repair may make destruction and replacement cheaper than repair.

Well-maintained buildings don't wear out. But if a building is abandoned or neglected, it will deteriorate rapidly. Since the unit cost of a system in new construction is cheaper than the unit cost of the same system in renovation, there will be a point where the percentage of systems to be replaced will make it cheaper to demolish the old building and build a new one. However, that rarely happens.

Some organizations have a policy to replace a building when its capital renewal costs exceed a high percentage (perhaps 70-80%) of replacement cost. Usually such guidelines are a blunt instrument in decision-making. They miss unique issues that are more important than the guidelines. Is the remodeled building as useful as a new one? Would a new one be more maintainable than the old one? Is there historical value in the old one?

Some owners wisely make sophisticated calculations to decide if investment in a new facility would be more cost effective in functional efficiency, energy consumption or maintenance expense. Then they consider the subjective aspects of history and esthetics.

Many historical buildings have been renovated at costs well above their replacement value because people wanted to keep them.

These economics of occupancy and durability are complicated—so complicated that we've never seen a complete model. It's conceivable, and it would be a wonderful assignment to undertake. It would include algorithms for energy consumption along with data on the energy savings of glazing, overhangs, insulation and HVAC equipment. It would include first cost, cleaning, routine maintenance costs, estimated replacement and life cycles of building systems. It would include our best guess about inflation and the changing cost of money.

And it would include assumptions about changing functional requirements that would certainly prove wrong. Inevitably, in these

The Utah State Capitol was renovated at a cost that was probably above its replacement value. But the historical value of the original was incalculable. For the addition, the design team (including CMs and subcontractors) designed esthetically compatible, large off-site fabricated components that could be lifted in one piece and bolted to the frame from inside the building. Shop assembly was faster and more precise and was concurrent with site construction. These techniques saved 1/3 the cost of conventional stone construction.

analyses the precision of the process is greater than the accuracy of the assumptions.

But until we develop such a model and develop confidence in our ability to guess at future requirements we can make useful assumptions based on the major issues that we do understand. Although greater precision would be informative, it's unlikely that it would change conclusions.

There is myriad technical data that result from assessing the condition of buildings —but two concepts stand out. By far the preponderance of the maintenance problems are directly related to things that move and to the problems caused by water.

Things that move

Moving parts wear out, need maintenance and replacement and typically consume energy.

The largest costs are the mechanical, electrical and plumbing systems (including security, controls and communications). The MEP systems are the most expensive to build, operate, maintain, repair, and the most expensive to change. It is likely to be the most important system to support the building's function. It controls light and air so it has measurable effect on human learning and productivity. Most of the study of flexibility must focus on MEP.

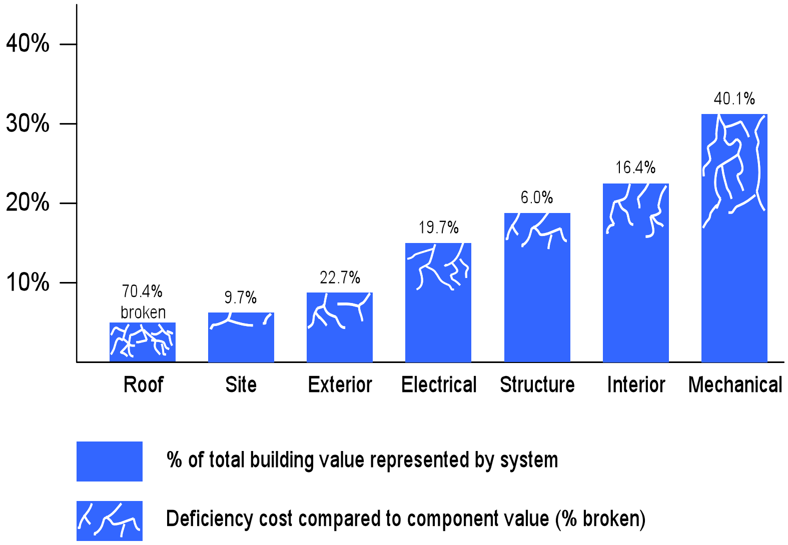
MEP is also the most costly system to maintain and the fastest system to become obsolete. HVAC control systems that are 20 years old are outdated. Advances in computer integration and control of building systems (HVAC, communications, audio-visual, security, computing, etc.) accelerate obsolesce. Commissioning, the control of building interfaces and the training of building occupants change design requirements.

Hardware, hinges and locks are the second category of moving parts that need attention and replacement.

Keeping the water out

In the 5000 years of recorded building history, we've not learned how to keep the water out. Water is the most common destroyer of buildings. Most roofs leak, damaging ceilings, walls and floors. Water seeps behind brick veneer, freezes and pushes the brick away. It does the same to concrete. It corrodes steel windows and doors and rots wooden ones. It seeps under asphalt paving and erodes the subsurface, creating potholes. It stands on the site, rendering it unusable long after the rain has stopped. It leaves mud behind that is tracked into buildings and destroys flooring.

Water is nature's most damaging solvent. It costs building owners astonishing amounts of money. Because water is so common and its damage is so universal, it's taken for granted.



In an assessment of 94 community colleges in California, 74% of the replacement value of the roofs needed to be spent on repair. For HVAC systems, the figure was 47%. The roofs were the most annoying problem, but the HVAC was the most expensive.

Sadly enough, most of the problems can be avoided with little cost. Water runs downhill. We can fight it with membranes, flashing, sealants, adhesives and other barriers. They will work for a while, then they will fail. Sloped roofs, overhangs, positive drainage are better (even thatch roofs shed water adequately). Fewer joints mean fewer places to leak.

Conclusion

- Long-lasting buildings are good investments for most owners. There is a premium for durability and for a handsome building, but it is not a great one. Modern methods of fabrication can reduce cost and provide both the reality and perception of permanency and quality .
- The primary reason buildings are demolished and their investment is lost, is that the site use changes. Good master planning is essential to protecting building investments.
- Buildings change their functions in unpredictable ways. It is likely that new buildings will house functions and technology that don't exist today. They can't be planned for, but the principles of flexibility are clear.
- There is never enough money, and first cost will usually bias an objective life cycle cost analysis. But there is not a large premium for durable, adaptable buildings and the payback is huge.