Future-proofing Architecture

By Michael Standing and Isobel Standing

"It's always building a bridge between times, between purposes … the architects are able to understand other traditions and other times and other understandings of life."

Father Martin Werlen, Einsiedeln Abbey (Werlen qtd. in Fannon et al. 146).

Father Martin Werlen highlights the importance of time in architecture. Paradoxically, structures have to survive across time yet also must respond to changing times. This article examines the issues of time and architecture and outlines a practical approach to embedding future-proofing into architectural design. This article then explores why buildings become future-proofed: they are designed to survive and meet sustainability goals, preserved because they express emotional and social meaning, and maintained if they continue to deliver economic value. These characteristics, particularly when combined, provide a platform for designing enduring structures and lead to five approaches for future-proofing buildings:

- Focus on adaptability,
- Use of scenarios to anticipate future needs,
- Embedding user-led processes and enabling evolutionary design,
- Defining design principles to shape the future, and
- Exploring the idea of 'timelessness'.

This article then outlines how to embed future-proofing into architectural design processes. Firstly, by mapping the 'future lives' of structures and then by helping architects, clients and investors to make future-proofing choices based on their purpose and intent for a building and their views on obsolescence. This article also examines how to economically evaluate choices by trading off the potential additional costs of generous, flexible architecture against higher income and improved terminal values of future-proofed structures.

Why future-proof?

The increased interest in future-proofing buildings (both in the design phase and in-life stages) has, in part, been driven by sustainability goals and the recognition of the carbon impact of demolishing and rebuilding buildings (embodied carbon accounts for more than 10% of global greenhouse gas emissions) ("What Is Embodied Carbon"). The Bullitt Centre, a six-story office building in Seattle, uses a future-proofed, durable architecture to deliver sustainability. The building, constructed of heavy timber and concrete, has a 250-year design lifespan, with a 'skin' designed to be replaced every 50 years (Wilson).

Buildings also become future-proofed through emotional and social processes. Michelle Laboy identified that the desire for preservation can flow from "personal histories, generations of families, the growth of a community, a sense of a shared place, and even an industry that provided them livelihood and pride in what they made" (Laboy 163). In Corning, New York, attachment to the old glass works led to the decision to keep the buildings and the factory whistle at the local power plant, which is still blown every day, even though the factory is no longer operational (Bennet qtd. in Laboy 163). On a different scale, emotional commitment can also emerge as a building becomes symbolic. Victor Hugo saw Notre-Dame as the primary vehicle for recording Paris’s history, describing it as a “vast symphony in stone,” and as a result, a symbol of France and its people that needed to be preserved (Hugo 120).

Economic return is the final factor driving future-proofing; buildings survive if they continue to be viable investments. This is particularly important in urban areas, given the changing demands for land use. In New York, many important hotels - the original Waldorf-Astoria, The Biltmore, and the Drake Hotel - were demolished and replaced by new buildings that offered higher investment yields (Untapped New York). In 1910, the Gillender Building in Manhattan was dismantled after standing for only thirteen years, despite being the world’s tallest office block when constructed, to be replaced by another skyscraper (Abramson 1).

How to future-proof

The underlying rationale for why buildings survive beyond durability - sustainability, emotional worth and economic value - influences the different approaches to future-proofing a design. Research into architectural theory and case studies identifies five frequently used approaches for future-proofing.

Adaptability, thinking about how a building's physical characteristics can support change without presupposing a structure’s future, is the first approach to future-proofing. As Stewart Brand argues, structures built with “generosity,” with light and tall ceilings, like British Victorian Townhouses, have the physical adaptability to survive (Brand 192). Considering maintainability matters too: enlarged spaces for service ducts allow for change and support new requirements. In the US, board and batten siding contributes to the longevity of houses by enabling easy access and repair (Brand 118). Alternatively, physical characteristics can also limit adaptability. Circular designs for buildings that need to expand, as with Paris' CDG Airport Terminal 1, are problematic. Other building types, like domes, are also structurally difficult to modify. In contrast, the architects Lifschutz Davidson Sandilands used a flexible, 'loose-fit' approach to design Hoxton Southwark, a speculative city office scheme in London which then metamorphosed into a hybrid hotel and coworking space during the planning phase. This approach, based on adaptable physical characteristics, such as a "number of 'soft spots' that allow floors to be opened up and stairs inserted," helped to ensure the building's relevance and longevity, and delivered sustainability and economic benefits (Whitehead).

The second approach is based on scenario planning and anticipation. This involves developing multiple potential futures for a building and establishing which 'future' occurs in most scenarios. This future then provides a direction for the design. The US Courthouse in Salt Lake City was designed using this approach (Fannon 198). For the short term, it was laid out with a flexible structure to accommodate the needs of many different types of government agencies, depending on demand. For the longer term, it was designed to support building a new fourth floor to provide additional courtrooms when required. While scenario planning cannot perfectly predict the future, it can be used to identify and avoid 'regret decisions'. Mark Crinson's analysis of Heathrow Airport highlights the three short-term factors - an existing military airfield, unused land and the flatness of the terrain - that resulted in London positioning its main airport directly west of the city (Crinson). Scenario planning might have led to a different outcome. The airport could have been built east of London to reduce aircraft noise across the city, and used a design in which the terminal buildings are not surrounded by runways, enabling the airport to grow with less disruption. Effective scenario planning requires a mindset shift to accept alternative futures, many not overwhelmingly positive, a willingness to live with uncertainty, and the ability to be flexible. Robert Goodspeed's analysis of Atlanta's Gwinnett County's *2030 Unified Plan* demonstrates the value of scenario planning at the level of the city and its buildings (Goodspeed xi-xvi). The city developed four future scenarios and selected two: 'International Gateway' and the 'Middle of the Pack', each reflecting different levels of optimism regarding economic growth. This framework provided a common ground and flexibility to effectively respond to changing conditions, and allowed the region to manage the consequences of and recovery from the 2008 recession. Adopting scenario planning supports adaptability and responsiveness, increasing the probability of a structure remaining relevant and raising its economic value.

The third future-proofing approach, user-led evolutionary design, hands design to the user, enabling them to modify a building over time to maintain its relevance and value. The approach explicitly accepts Stewart Brand's contention that "a building is not something you finish. A building is something you start" (Brand 188). In this approach, the architect builds adaptability into the design, but also develops *processes* to enable the user to reconfigure their building. This could include providing detailed design specifications to facilitate redesign, or a 'log book' recording previous changes to the building. It also involves the architect letting go and allowing the building to evolve on its own. The architects Anne Lacaton and Jean-Philippe Vassal hold the view, "Good architecture is open – open to life, open to enhance the freedom of anyone, where anyone can do what they need to do" (Anne Lacaton and Jean-Philippe Vassal).

As a result, their buildings, particularly housing projects, are built around maintaining flexibility and “generosity of space” (Ray). They use an inside-outside design approach that prioritises the needs of residents and creates opportunities for customisation. Alternatively, the failure to incorporate user-led evolutionary design and the consequential harm to residents is evident in many of the large housing estates built in the US and Europe in the 1950s and 1960s. At the infamous Pruitt–Igoe housing project, the architect designed the lifts to stop only at every third floor to encourage residents to intermingle on the interconnecting stairs. However, they failed to understand the realities of living in these buildings and how the stairs between floors would be used; instead of encouraging a sense of community, the stairwells became crime scenes (Bristol 166). As a result, the building complex was demolished after only eighteen years of occupation. The approach of adaptability - of engaging with users, transparency of design and the idea of “handing the building over,” is exemplified in Alejandro Aravena's Quinta Monroy housing project in Chile (Spotlight: Alejandro Aravena). The houses are designed to support evolving family life. With a low-cost frame, new floors can be added, and outside spaces, like patios, can be converted into new rooms. The buildings are designed to enable owners to expand their homes when they need to and can afford to. Furthermore, the approach created a new relationship between the residents and the buildings, with a strong sense of ownership and increased emotional engagement.

The fourth approach uses design principles to shape and to ‘fix’ a structure’s future architecture, ensuring long-term consistency, coherence, and relevance even as the building’s size or functions change. The design principles can define physical attributes (materials and structure) or conceptual ideas (the building's relationship with its site, spatially and historically).

The existence of physical design principles is evident in European cathedrals. Frederick Brooks argues that these principles enabled eight generations of builders to construct Reims Cathedral in a manner which retained the building's overall coherence (Brooks 42). Similarly, Antoni Gaudí's Sagrada Família maintains design coherency through physical principles based on geometric forms and "ruled surfaces" (generated by moving a straight line through space) (Burry and Burry 438). Use of constant proportions between objects, based on one-twelfth ratios (the floor plan is derived from a 7.5-meter module, a 1/12th of the total length of the cathedral), also reinforces design coherence (Geometry and the Sagrada Familia). Gaudí's design principles were communicated via models (rather than blueprints). When these were destroyed, the underlying logic of his design was so embedded in the building that it could be reverse-engineered to allow construction to continue (Burry and Burry 440).

The consistency of the design of Reims and Sagrada Família Cathedral also reflects conceptual design principles frequently found in Christian buildings: continuity, longevity and permanence. The Trappist Monks of Saint Joseph's Abbey hold the principle of a lifelong commitment to a specific monastery. According to David Fannon, this influenced the design of the monks' brewery, which was engineered to anticipate change, to limit the need for modifications and ensure the building's permanence (Fannon 204). Einsiedeln Abbey, founded in 934, is based on the principle that each generation of monks is the caretaker for the next. As a result, the design of new buildings emphasises continuity and longevity. Father Martin Werlen stated, "We are the same family, built a thousand years ago … we continue what the people before us have done … studying the old windows and using the experience of times ahead to make something modern which continues this tradition" (Werlen qtd. in Fannon 241).

These conceptual principles, which shape and fix the future of a building, are also found in non-religious structures. Herzog De Meuron's Tate Modern, opened in 2000, retained the original building's masonry structure to reflect London's urban and industrial past (Moore and Ryan 48). The architects, when designing the extension in 2016, returned to the same material, 'London Brick', as a restatement of historic continuity and future relevance (Dercon and Serota 21). The effective use of principles to future-proof a building is based on the idea, as Liliane Wong states, that structures have their own DNA (Wong 124-128). It is important that the principles, physical and conceptual, are understandable and can be translated into future building designs to create continuity, coherence and ongoing relevance. When used effectively, they can reinforce a structure's emotional worth and can simplify future construction.

In one more sense, a building can be future-proofed if it is designed to be 'timeless'. Peter Zumthor captures this idea when he states, "I have a passionate desire to design … buildings that, in time, grow naturally into being a part of the form and history of their place" (Zumthor 17). This leads to the idea of a building having a relative time, for example, a patina of age moving at the same pace as its surrounding environment, creating a sense of timelessness. This was achieved in Zumthor's Therme Vals, built in Switzerland and constructed with locally quarried Valser quartzite stone. The material ensures alignment of the ageing processes, resulting in a harmony of colour between the building and its environment over time, reflecting Zumthor's belief in the "union of human work and nature" (Zumthor 97). As an alternative, Martin Werminghausen argues that timelessness can be achieved by designing around the human form and persona: "What is not uncertain … the human-being. If there is a human-being there are certain things we rely on. This won't change. This has to do with the social sustainability that must be found" (Werminghausen qtd. in Laboy 162). Frank Lloyd Wright took a third approach, rooting buildings in nature to create timelessness, as he stated, "No house should ever be on a hill … It should be of the hill. Belonging to it" (Wright 160). His most famous building, Fallingwater, achieves integration with the landscape through its construction and choice of materials. The horizontal concrete terraces mirror the natural strata, while the use of locally quarried sandstone blurs the boundary between building and the hillside. These ideas, also developed by Christopher Alexander as a process, result in structures with emotional resonance and a sense of being immune to the passage of time (Alexander 3).

Approach

Applying these approaches in a design process requires the ability to define the stages of a building's evolution, to select the appropriate approaches for future-proofing, and to evaluate their costs and benefits. It also requires a certain mindset, a modesty, where the architect accepts that their buildings must have their own destiny.

To understand a building's timeline, it is useful to map out four S-curves (see Fig. 1). The first curve defines the historical context, the second curve determines the initial design and construction, the third curve outlines potential mid-life physical restructuring or change in function, and the fourth curve sets the direction to a long-term vision or outcome. This structure provides an initial framework for defining the time periods in a building's evolution, which can then be modified by either adding or removing S-curves, depending on the complexity of the building. For major projects (a decade or longer), there are typically six to eight S-curves. The framework can be used left to right to project forward from the initial design, or applied right to left, starting with a target future and then reverse-engineering to define the individual steps to get there. For example, a 30-year vision for a deep mine would project the replacement of miners with robots. The intermediate S-curves would map out the process and implications to achieve that vision, including the redesign of the mine, access routes and maintenance facilities, as well as the investment in local communities to support the transition of miners to new job opportunities above ground.

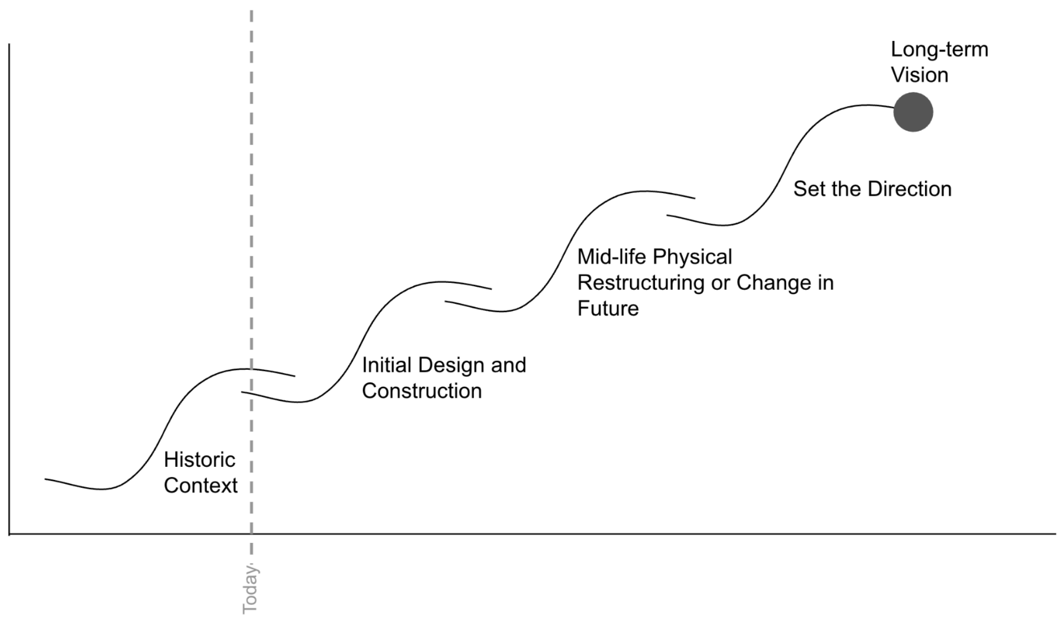

Fig.1. A building's timeline (four S-curves)

The process of selecting the most appropriate future-proofing approach is complex and involves discussions between the architect, clients, investors and regulators. To help facilitate this process, it is useful to pose two questions. Firstly, is it the design intention that the building should be able to evolve or is the aim to specify a building with a fixed purpose or structure? Secondly, what are the views of the architect, clients, and investors on ‘obsolescence’? Do they accept that buildings are prone to obsolescence and need to be actively rejuvenated, or should they be allowed to be demolished? Alternatively, is it their perspective that buildings do not become obsolescent and that it is important to retain continuity over time? As Daniel Abramson argued, “many architects accepted obsolescence and even embraced its promise, others recoiled from obsolescence's consequences and implications. They rejected its apparent inevitability” (Abrahamson 107). The answers to these questions can be translated into a decision matrix to help choose the most effective future-proofing approach for a building in a given situation. The y-axis captures the required specificity of design direction, ranging from open or ‘loose' to defined or set. The x-axis captures the view of decision makers on obsolescence: are buildings prone to obsolescence or not?

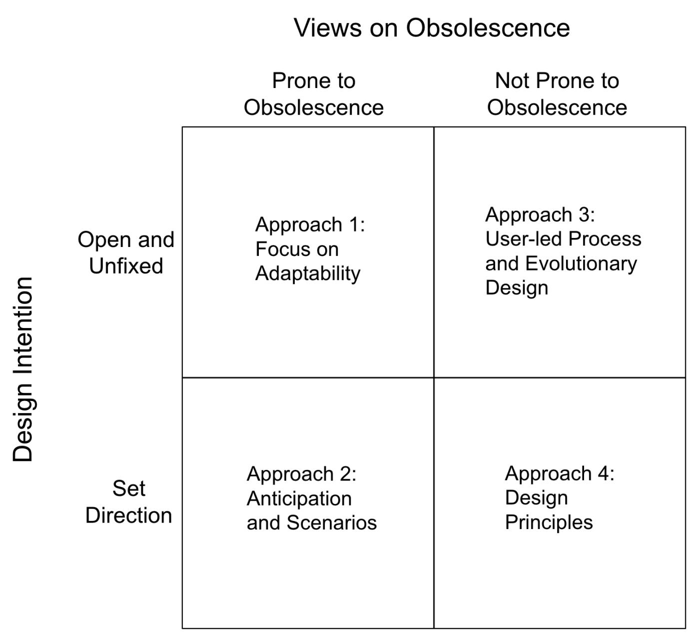

Fig.2. Decision matrix

Understanding where the decision makers sit on this matrix can help to determine the most effective approach to future-proofing. If the decision makers have an open, ‘loose’ view on the design of the building while holding the perspective that the building will likely become obsolete (as with a general-purpose factory or warehouse building), then approach 1, focusing on adaptability, is the best starting point. If there is a need to set direction and there is a high probability of obsolescence (as with technically complex buildings like airports), then approach 2, anticipation and scenarios, is a better fit. In situations where obsolescence is not seen as inevitable, and there is a need to maintain an open design, as with housing for families growing up in neighbourhoods, then approach 3, user-led processes and evolutionary design, has proven to be effective. If the design criteria are to define a building with purpose, which should not become obsolete, for example, for symbolic public buildings: churches, monuments and memorials, then the most useful approach is option 4, using design principles, which shape and 'fix' the future of the building. Buildings which have a purpose, but which *ignore* obsolescence, to create tranquillity and a place of contemplation, such as religious structures and university buildings, are best served by approach 5, timelessness.

The economics of future-proofing is going through a period of change. While there are examples where future-proofing does reduce costs, oftentimes designing for flexibility and adaptability, creating a generosity of space, can add to design and construction costs. These costs are predictable and relatively easy to calculate. The greater challenge is in determining the financial benefits of future-proofing, particularly if they are delivered over a long time or affect society as a whole. However, analysis by WEF indicates that "reusing built assets can deliver 12-15% in cost savings by avoiding the expenses associated with demolition and new construction" (World Economic Forum). Siavash Ghorbany argues that "increasing the building lifespan to 80 years with a 20% reduction in building sizes can decrease carbon emissions to one-third of the current value" (Ghorbany 1). In addition, in the UK, demonstrating future-proofing and sustainability increases the probability of receiving planning permission (Ministry of Housing, Communities and Local Government, para. 8b). Nevertheless, further work is required to develop ways to measure the broader societal benefits of future-proofing, including cost savings, a lower carbon footprint, less disruption, and the preservation of urban spaces.

Broadening the application of future-proofing involves a mindset shift. From a rational perspective, many architects understand the environmental and economic benefits as well as the potential emotional consequences of designing buildings that survive. However, as José Rafael Moneo argues, future-proofing also requires a degree of humility, an acceptance that a building exists independently and separate from the architect: "When architects realise that a building masters its own life, their approach is different; it changes radically. Our personal concerns become secondary, and the final reality of the building becomes the authentic aim of our work" (Moneo). This step is integral to a building becoming future-proof.

By incorporating these pragmatic steps into the design process, architects can enable future-proofing, with important environmental, social, emotional and economic benefits. The positive effects are cascading: the architect and client extend their legacy into the future, the investor achieves improved returns, the contemporary public enjoy a robust design, future generations can experience the living history of their city through enduring architecture, and the planet benefits from a reduction in carbon emissions and increased sustainability.

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