Building for Longevity:
The Oskar von Miller Forum as a Case Study in Maximizing the Useful Life of Buildings

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INTRODUCTION

The Oskar von Miller Forum is a
recently completed facility (December
2009) near the Technical University
of Munich, designed by the architec-
tural firm Thomas Herzog + Partner.
Funded by the Bayerische Bauwirts-
schaft (the Construction Association
of Bavaria), the building serves as a
housing facility for students and young
professionals in the building industry,
as a guest house for visiting scientists
and professors, and as a conference
center. Dedicated to “promoting a
holistic image of construction engi-
neering across multiple disciplines,
...the Forum acts as a platform bring-
ing together construction engineering,
surveying, architecture and the skilled
trades.”

Fig. 01 The Oskar von Miller Forum, viewed from the southwest.

Architect Thomas Herzog, well known
for decades for his pursuit of sustain-
able design practices, was given the
rare opportunity of a generous bud-
get in the Forum commission, both
to implement well-established best
practices of sustainable design, as
well as to experiment with the lat-
est technological systems available
on the market. He was also given
the unheard-of opportunity to create
and define the building’s program as
he saw fit, provided it supported the
client’s vision of serving young people
in the building industry. The Forum
was intended to be a house for com-
municating ideas and for fostering a
certain culture, all in service to the
public. What this meant in detail was
almost completely undefined at the
outset, adding enormously to Herzog’s
This paper analyzes the Forum as a case study of sustainable design practices, and does so through two lenses. First is as a combination of technologically advanced components that work together as a sophisticated and intelligent building system. Second is as an example of design strategies that address a building’s design service life, which is defined to be the length of time in which a building or its components is reasonably intended to function without unforeseen disruption or cost. The primary question here relates to ways in which the architect designed the building for flexibility to accommodate future needs. These may include such things as renovations, changes and updates to infrastructural systems, or programmatic shifts that cannot be anticipated at the outset. The goal of these strategies is to make future changes to the building as straightforward and inexpensive as possible, thereby maximizing the useful life span of the building as a whole.

LONGEVITY AS A CONCERN

In centuries past, buildings were designed with no regard to a design service life, but simply designed to last. Typically, durable construction of public buildings and many residential buildings guaranteed that they would structurally withstand the test of time. Furthermore, the veritable absence of changes in needed infrastructure and programmatic requirements before the industrial and informational revolutions meant that the building would not become obsolete or require major interventions for renovation or updating.

In the 20th century it is easy to see how both of these realities began to change. Economic pressures and resulting business strategies motivated the design of buildings with intentionally short life spans. For example, in the United States, a typical Wal-Mart store today is intentionally designed to last no more than eight years. Also, technological advances and heightened requirements for human comfort and convenience have meant that buildings require additional systems in order to remain useful. We have all noticed older buildings in which plumbing fixtures and pipes, electrical outlets and conduits, and forced ventilation HVAC systems have been installed. In many cases the heavy masonry construction made it impossible to hide the undesirable presence of these systems, and the aesthetics of the building’s interior often suffered greatly in the modernization process (Figure 02).

The same type of problem in reverse now exists in modern buildings, particularly from the late 20th century, where a presumed adequate supply of cheap energy informed design choices that make it all but impossible to update the building to be truly
sustainable in the 21st century. For example, daylighting and ventilation strategies, for centuries a conscious consideration in building design, became irrelevant with cheap artificial lighting and HVAC systems. The difficulty of updating these buildings to necessary standards of livability and sustainability motivates the questions here, in hopes that we may not continue to make such design choices, which we can no longer afford (Figure 03).

Whether we are reflecting on the updating of centuries-old buildings in the 20th century, or the updating of 20th century buildings for the 21st, the lesson is the same: How can we best design buildings today to accommodate both current needs, which are known, and future needs, which are unknown or even unknowable, so that a building constructed today will have as long a useful life span as possible? The question is a complex one, and the answer is not simply that a building and all of its components and systems should be as advanced, robust, or durable as possible. Adaptability has many implications.

OVERVIEW OF THE OSKAR VON MILLER FORUM

Figure 01 is a view of the Forum from the southeast, and Figure 04 shows the context and site plan of the building. To the immediate west of the Forum lies a five-story office building. To the north of this office building lies a long row of garages, which have occupiable green roofs accessible from the residential units immediately to their east. The courtyard to the east of this residential building provides access to street-level commercial space, and the street-front building to the east of the courtyard is a typical mixed-use building, a common site across Munich.

The U-shaped Forum building includes an eastern wing with a bistro on the ground floor and four floors of apartments above. The south wing houses a two-story height lecture hall, five floors of student housing with adjacent study areas and kitchens, and a seventh floor gathering space for dinners, parties, and lectures. The west wing, which opens into the central courtyard, houses primarily a library and administrative office spaces. Vertical circulation space resides primarily in the two corners where the wings meet, and two underground levels house service spaces, parking, and much of the equipment for the building’s environmental and energy systems. Figures 05–08 illustrate the Forum in plans and section.

FORUM DESIGN STRATEGIES

The typical expected life span of a building in Germany is approximately 80 years. The CEO of Bayerische Bauwirtschaft, by keeping an open mind about the Forum’s program, allowed Thomas Herzog + Partner to design with this typical life span in mind, while also being able to ask open ended questions about what the building’s role and its situation in the neighborhood might look like 20 or 30 years in the future. This vision manifests itself in several building strategies implemented in the Forum.

Hierarchy of Components

One of the first things a visitor to the Forum might notice is a unique set of relationships between the building’s components—structural and infrastructural. In particular, the Forum reveals a very legible hierarchy of
components, with clear and intentional relationships between them. This strategy was driven in part by design service life considerations.

The structural frame of the Forum is illustrated diagrammatically in Figure 08. Prefabricated columns were assembled on site with thin, prefabricated floor plates. Prefabrication of these components allowed for a quality of finish that would not have been possible if they had been poured in situ. Because the floor plates were to be visible from below, these thin “shells” were lifted into place floor by floor, layers of gravel and screed were poured on top (for reasons to be discussed in the next section), and the final floor surface placed on top of this. Troughs for electrical conduits and other material flows could then be easily incorporated during the construction process. Though some conduits are flush with other surfaces while others are attached onto them, the resulting relationships are elegant, and contribute to the consistently visible hierarchy throughout (Figures 09–12).
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Fig. 09  Shear wall on the Forum’s west end stands in relationship to dry wall opposite, whose detailing in construction reveal clearly that it is an inserted component. Door and window read as a single unit, inserted into place. Balustrades and their attachment to floors and stairs were detailed in the early design phase for precise prefabrication. Light fixtures throughout read as plug-and-play components, whose materiality and form are consistent with the elegance and quality throughout. Sprinkler system conduits (discussed in a later section) align with other edge conditions and intrude minimally.

Fig. 10  Prefabricated floor panels house a dry wall insertion, and are abutted to the building skin components. However, the building façade system does not hang from these plates. Instead both the north and south facades hang from the roof in an overarching system somewhat analogous to a tablecloth. The minimal number of steel connections through the building skin layers therefore lessens thermal bridging and reduces winter heat losses.

Fig. 11  Wet bar and coat closet on the reverse side read almost as a piece of furniture in the lecture hall.

Fig. 12  Prefabricated staircase components occupy their own place in the hierarchy of building components. Lighting strips underneath are standard, commercially available units that are presumed to be installed on a flat ceiling. However, these were specially adapted for the stairs so that the fins point directly downward to shield the building occupants eyes from direct light.
There is another interesting hierarchy of components present in the Forum, and this is in the HVAC system. This very complex and technologically advanced system evolved through some unexpected stages into a final form that arguably is more friendly to design life considerations than the initial ideas might have been. It incorporates both computer and user inputs and actions, convection, conduction and radiation, and both natural and forced ventilation. The overriding themes throughout are the use of thermal mass to create a comfortable environment and the use of renewable energy to drive the mechanical systems.\textsuperscript{6}

**Natural ventilation**

Herzog + Partner conducted extensive simulations of airflow in the design of the Forum’s natural and forced air ventilation systems. The architects were most concerned with the effectiveness of comfort in the living quarters, for these are used almost all

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**Fig. 13** Free-form blue arrow illustrates the intake location for naturally cooling the student quarters.

**Fig. 14** First floor, eastern stairwell. Louvered windows on the north side open automatically when needed, or when triggered by user action in the student common areas.

**Fig. 15** User-operated doors on the east end of the student common areas trigger the opening of lower level windows in the stairwell, and allow air to be pulled across the space to the double-skin façade or through the kitchen area.
of the time. Figures 13–15 illustrate the induced convective flows for the student wing and adjacent stairwells.

Though it is impossible to separate completely the effects of natural and mechanical air circulation, the natural convective flow patterns through the student quarters can be understood in the following way. First, Figure 13 illustrates how naturally cool air on the building’s shadier north side is drawn into the stairwell on the building’s lower levels. Figure 14 shows the louvered window on the first floor of the eastern stairwell. Intake air is pulled through the stairwell and can enter each of the five floors of the student quarters through ventilation doors on the eastern end of the common areas. These doors (Figure 15) have porous panels behind them, and are user operated. When an occupant opens this door, it triggers the automatic opening of the louvered windows in Figure 14. Once entering the student common area, the air is pulled toward openings in the double-skin façade and toward the kitchen at the western end, to be expelled to the outside.7

Radiant cooling and heating

The second level in the hierarchy of the HVAC system is the building’s ability to exploit thermal mass by actively cooling or heating the floors. In many weather situations, this is adequate to create thermal comfort, and the Forum’s solar thermal collection system handles the entire task.

The roof of the Forum is covered with vacuum tube solar thermal collection modules (Figure 16). The fluid medium in the system is glycol, which has a lower freezing point than water. The glycol, heated by solar energy, is forced downward to the basement...
through four insulated pipes, whose presence in the western stairwell creates a sense of continuity and connection between the floors (Figure 17). This stored thermal energy drives a solar thermal absorption chiller, which chills the water that is to flow through the floor pipes.

The assembly of the Forum’s column grid and floor shells mentioned previously is related to the insertion of the thermal mass heating/cooling system. After the thin floor shells were assembled, pipes for circulating hot or cold water were laid in the troughs (visible in Figure 08). These were then covered with gravel, and then a layer of screed was applied to smooth the surface for the application of the finish floor. Because the temperature difference between the cooling water and the air is relatively small (62—64 deg F for the circulating water), and because the relative humidity of the interior air is moderate, condensation in summer is never an issue.8

**Mechanical ventilation for cooling**

Two scenarios could compromise the ability of the two systems discussed thus far to cool adequately—hot weather, which is not infrequent during Munich summers, and occasional heat loads created by large groups in the lecture halls or bistro. To address these occasional occurrences, the Forum includes two independent mechanical cooling systems.

The first mechanical ventilation cooling system to activate during hot weather or large gatherings is powered by the same solar absorption cooler that chills the water for the floors. Immediately we see how the presence of such a forced air system complicates the building’s overall

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8. For more details on the solar thermal system, see the section on energy efficiency and sustainability in the project’s environmental impact report.
cooling strategy and requires its own infrastructure, which furthermore must be effectively coordinated with the infrastructure and operation of the natural ventilation system.  

Figure 18 shows the forced air registers in the bistro, which are non-descript boxes on the floor that create a pool of cool air. A similar register was placed at the east end of the 7th floor hall, and Figure 19 shows how the air is pulled across the room in order to be expelled through the toilets on the western end. Figure 20 reveals that another similar register is positioned at the east end of the ground floor lecture hall, which is pictured in Figure 21.

Figures 20 and 22 reveal in plan and section yet another airflow strategy in the lecture hall, which introduces cool air laterally overhead toward the exterior walls, and which then falls to the ground. The location of occupants, which will more likely be toward the center of the room, suggests that the rising heat loads they generate will be removed most efficiently by pulling air from the center of the ceiling.

Finally, Figure 22 indicates the placement of vertical shafts in the core of the student quarters. This strategic location allows for air movement in patterns consistent with the natural ventilation flows, and directly serves both the common areas and the individual student rooms.

The final element in the overall cooling hierarchy is the last system that would be used in hot weather. It is a conventional vapor compression cooler, which runs on a standard electricity source from the Munich grid. Because of the other systems in place at the Forum, the size of this component...
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is approximately one-tenth of what would otherwise be required.12

Additional heating system

Winter heating needs exceed summer cooling needs in Munich, and the Forum is also equipped with a system of hot water radiators to meet these needs. The concept is simple in principle: either solar thermal energy collected from the roof panels or heat supplied by a district heating source is used to heat water in the Forum basement, and this water is then pumped through the building’s radiators. Given that the entire roof of the Forum is covered in thermal collectors, it might seem surprising that the building is tied into district heating. The reasons for this are addressed in the next section.

Energy Considerations for Thermal Comfort Systems

The choices of cooling and heating systems described here were not exactly the architect’s original intent, and a brief account of the story is relevant. Concerning cooling, initial studies indicated that solar cooling could in theory meet base loads and that nighttime cooling would usually be adequate to flush daytime heat gains. Concerning heating, it was clear that there would be problems related to the amount of solar energy available during long winter gray spells. Also, the amount of water required to store thermal energy through these times, and even through the night on typical winter days, was extreme.

At first the intention was to store this large amount of water, whose presence would be justified because it would supply the sprinkler system in the event of a fire. However, the architects eventually decided on a more desirable and sustainable solution. First, they decided to tie into Munich district heating to supply approximately 60 percent of the Forum’s heating needs. This allowed the architects to include a high pressure sprinkler system. This system requires storage of only 6000 liters of water, and it allows for narrower distribution pipes throughout the building. The infrastructure is much more aesthetically desirable than a standard system. Furthermore, because the high pressure sprinkler system extinguishes a fire by creating a fog instead of dousing the fire with liquid water, water damage caused by the sprinkler system is much less of a concern. This system is likely the only one of its kind in Germany (Figure 23).13

The choice of district heating and a high pressure sprinkler system allowed the architects to recover an entire room in the basement (of approximately 80 sq meters), which they equipped with disco lighting and
sound equipment, and dubbed the Partyraum. If the room had served its original purpose of water storage, we can see that early design stages had anticipated the need to store on the order of 440,000 liters of water for thermal storage and fire protection purposes.\footnote{14}

With the decision to tie into Munich’s district heating system, the architects addressed the question of using this heat to help drive the thermal cooling system. At the time they assumed the heat would be delivered by steam, but there was discussion that the city would convert the district heating to a hot water supply instead, which would circulate water at 80 deg-C. The architects calculated that this was adequate to drive the Forum’s thermal cooling system, and the Forum might have been the first building in Germany where district heat from water was actually used for summer cooling. However, the conversion of district heat supply to water would have rendered obsolete a number of absorption chillers currently running on steam. Furthermore, there was no thermally driven absorption cooling system on the market at the time that could run on 80-degree water, though the architects were assuming that such a system would be available by the needed date. The client was not willing to take this risk. These complications explain why the architects ultimately chose the hybrid system described previously.\footnote{15}

Other Design Considerations

The useful life span of a building ought to include aesthetic considerations. In the example of the high pressure sprinkler system, the needed infrastructure is less intrusive than a traditional system. Though any such

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{high_pressure_sprinkler_system}
\caption{The high pressure sprinkler system allows for smaller conduits and is well integrated aesthetically with the building’s other systems.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{green_roofs}
\caption{Extensive green roofs cover most of the Forum.}
\end{figure}
system can be masked, Herzog + Partner managed to incorporate the system’s infrastructure in ways that are consistent with the design concept for lighting and electrical systems. Thus the sprinkler system, rather than being hidden behind a drywall ceiling, is part of the overall design scheme. As a result, it is easily accessible (Figure 23).

The forum contains several segments of green roofs, like that in Figure 24 over the administrative wing. A casual glance across the rooftops of Munich suggests that such extensive green roofs (i.e. with a thin soil layer, limited accessibility, and minimal required maintenance) are quite common. According to Schneider, the green roofs of the Forum are robust and did not require consideration as part of the building’s design service life.16

FUTURE ISSUES

Critical to maximizing a building’s design service life is consideration of its future needs. Some of these are easy to anticipate, such as repair and updating of certain infrastructural systems. Others, however, cannot be “planned,” but only “planned for.” Programmatic changes, changes in the urban fabric of the neighborhood, needs for new technologies not currently available, and new infrastructure required to meet future challenges created by climate change are but a few examples of the issues that might require a building to adapt. The Forum architects consciously considered some of these possibilities, and might have unwittingly left room for others.

Programmatic Changes

Before Thomas Herzog + Partner were hired to design the Forum, the client had consulted with another architectural firm. Their concept was that the Forum would be a student housing facility, and there was no broader vision to inspire other opportunities or to motivate consideration of future changes in need. These limitations would have proved fatal to the project, for Munich city planners would undoubtedly not have allowed such a one-dimensional and self-serving facility to have been built on one of Munich’s prime properties. By opening up the concept and creating a Forum to serve the community, and by considering other possible programs that might occupy the site in the future, Herzog + Partner were able to secure the required building permits.17

Two scenarios that the architects considered were that the Forum might someday serve either as a hotel or as an administrative building. Keeping these and other possibilities in view had several direct implications on the Forum’s design. For example, in the hierarchical construction strategy discussed previously, certain walls were built as non-load-bearing dry wall segments. These were strategically positioned to allow for easy reconfiguration of space, in particular around the stairwells, so that doors could easily be added or moved in the event of program change.

In the event that the Forum were to be converted into a hotel, the architects anticipated that guest rooms would be built into the common areas on the student residential floors. How the added partitions would impact
the natural and mechanical ventilation flow patterns is complex, but the architects considered this impact. This reveals one more reason that the vertical ventilation shafts for the mechanical ventilation system were placed along the central axis of the floors instead of, say, along the north wall. For them to be centrally located means they could serve private rooms on both the north and south sides of the wing.

Because the floor plates were prefabricated with recesses which were then filled with gravel and covered with screed, they allow for the floor to be opened easily. Thus additional water and electricity can be supplied to the converted spaces without having any impact on the building’s main supporting construction.¹⁸

The architects designed the ground floor lecture hall with a detail that one might not notice. Figure 25 reveals an array of holes in the columns and in the ceiling panels. Because the lecture hall is a two-story space, the architects anticipated that significant loads might be introduced in the future, including but not limited to the insertion of an entirely new floor. By including these points of attachment, future loads can easily be transferred directly to the existing columns or to the ceiling beams by screwing in steel rods. Clearly the expense of adding these details was minimal, while the potential future savings could be significant.¹⁹

Not only did the architects anticipate that the Forum’s current program might not last, they also anticipated that it might outgrow its current site. As a result, the architects considered the possible merging of the Forum with the office building to the west. In the event that this office building were to be for sale in the future, the architects included several strategically chosen points in the western stairwell where walls may be easily removed and the two buildings connected.²⁰

Water Challenges

It has been said that water is the next big environmental challenge. The change in the choice of sprinkler system for the Forum meant that a large basement space was not needed for water storage. Perhaps this space will acquire an unforeseeable function in the future, in the event that some type of water management system must be installed.

Two water supply loops (regular and distilled). Distilled is for dishwashers and chillers. Thus the Forum includes a water softening system and two separate water supply loops throughout the building. This is the Forum’s only water management system other than the municipal code requirement that rainwater runoff be diverted to a system of drainage pipes that is distinct from the city sewer.²¹

Climate Change Considerations

Though it is mere speculation, the Forum’s four-tiered cooling system might have been a happy accident. Over the past several years, Europe has seen several catastrophic heat waves. The Earth Policy Institute estimated that the record heat wave across Europe during August 2003 was responsible for the deaths of 35,000 people among eight Western European countries. Seven thousand of these deaths were in Germany.²² Such heat waves across Europe are almost certain to increase in frequency and intensity. Thus cooling needs for the Forum will only increase, and the system designed by the architects should be more adaptable and easy to update than it would otherwise have been.

Other Technical Issues

Much of the modernization of very old buildings in the 20th century involved the accommodation of flows that had not been needed before, such as water, electricity, and forced air. The solid wall construction of these buildings and an understandable absence of porosity meant that in many buildings, the insertion of conduits had unfortunate aesthetic implications (Figure 02). Perhaps no one can know what additional flows, if any, the building of the future might be required to accommodate. Based on the analysis of the Forum thus far, we can be hopeful that its construction hierarchy and current flow considerations will help it adapt and accommodate any additional flows required in the future.

TWO PERSPECTIVES ON BUILDING SERVICE LIFE

Two publications concerning the useful life span of buildings can offer perspective on the questions addressed here. One relates to a paradigm for architect/client interactions that might lead to a building whose adaptability could lengthen its useful life span for the client who commissions it. The other offers a perspective on green building rating systems and some of the design service life questions they do or do not address.

Flexibility Profile Indices

Open building is a design concept whereby potential future needs are taken into account in a building’s
development phase, with the goal of creating a truly adaptable building. These include social, environmental, and technical requirements and their potential changes. A measure of the ineffectiveness of adaptability is the number of vacant buildings in an area. In "The Future Value of Buildings," Geraedts discusses a quantitative measure of the flexibility of installations, which can then serve as a measure of the flexibility of a building as a whole.

This measure focuses on flexibility choices that do not lead to additional investments, which are the most interesting such considerations. Author distinguishes between two levels on which the Flexibility Performance Indicators (FPI) can be calculated: the local level (that is, on or near the level of the individual), and the central level (on the scale of an entire floor or wing of a building, or the whole building itself).

The FPI consists of four components: 1) Partitionability, the possibility of building spaces to split, rearrange, or combine into new configurations with simple intervention; 2) Adaptability, the ease with which buildings and their components can be changed according to future user demands or altogether different building use; 3) Extendibility, the capacity to accommodate additional user demands of space and/or functionality; 4) Multifunctionality, incorporation of systems and components that are suitable for several distinct functions, thereby making more efficient use of available space.23

By assigning numeric scores and weights to these components, a graphic measure of a building’s FPI can be created, suggesting at least some measure of success. A graphic image like that in Figure 26 provides a visual sense of how different flexibility profile types result from consideration of a client’s unique needs. Without going into further detail here, it suffices to note that the author’s FPI, even if it serves of little value as an assessment tool, could effectively guide architect/client conversation into serious consideration of potential future needs.

An obstacle to building for flexibility is that a future user, who would likely be the party requiring changes in the building to accommodate different needs, is likely different from the initial client. Thus there is often a lack of incentive for the initial added expense of incorporating flexibility, even though future adaptation would be significantly more expensive without such initial considerations.

Green Building Assessment Programs

Another perspective on building design life is offered by the Athena Institute. In their 2006 report, they note that “there appears to be widespread support within the green building community for taking building service life explicitly into account in rating systems,” such as LEED and Green Globes.24 Limited empirical evidence implies that it is not clear what are all the variables that determine a building’s useful life span. Nor is it necessarily true that sustainability concerns dictate that a building be designed with as long a service life as possible. It is important, however, to design a building for deconstruction when its useful life is over.

The Athena report notes that there are tools to help take the service life of a building into account in the design process; particularly those embedded in the CSA 478-95 guideline and the ISO 15686 standard.25 It speculates that the apparent infrequency of their application might be due in part to their complexity and the resulting lack of expertise that would characterize most design teams. Another reason is that compensation for the design team is typically inadequate to motivate life span considerations beyond...
basic code requirements. Furthermore, there is the typical emphasis on first costs at the expense of long-term planning.

Relevant to the questions here are the possible changes in urban fabric that can affect a building’s useful life span. The Athena report points out that in certain situations it might be better to plan intentionally for a relatively short life span, and therefore design with disassembly or deconstruction in mind. It also notes that developers of green building rating systems have found it very difficult to address building life span considerations in any holistic way, where building and material service life, building construction, and green building systems are conceived as an interrelated whole.

CONCLUSION

Sustainability in architecture is a complex and multi-faceted concept. Of the many metrics that have been used with which to quantify how sustainable a particular building is, probably the metric most accepted as central to the question of sustainability is the amount of energy a building uses across its entire existence.

Because buildings require massive amounts of energy in their construction and demolition phases, it is reasonable to believe that sustainability as an architectural pursuit implies that we will build and demolish less. The obvious implication of this is that buildings will need to last longer—to be durable and adaptable to future needs.

It is essential that the architect of the 21st century design with these ideas in mind. The result will therefore be buildings whose useful life span could easily be well over 100 years, in their structural integrity, suitability, livability, and aesthetic quality.

Notes:
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