

Interior Environmental Design Methods for the Functional Adaptation of Existing Buildings in the Old Urban Area

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Abstract: The functional rezoning of existing buildings in older urban areas is constrained by existing spatial scale, structural boundaries, and original environmental conditions. Following the introduction of new functions, new adaptive requirements often arise regarding spatial usage, natural lighting and ventilation, acoustic and thermal environments, as well as equipment configuration. Indoor environmental design should determine spatial and performance requirements based on the reconfigured functions, harmonize the original conditions with the new demands while minimizing the disruptive impact of the renovation, and implement design solutions encompassing adjustments to the spatial layout, improvements to the lighting, thermal, and acoustic environments, and the integration of materials and equipment—ensuring that the internal environment of the existing buildings accommodates the new usage scenarios while preserving spaces and structural features that retain practical value.

1. Introduction

Within the long-established building stock of the old urban area, certain residential, commercial, office, and industrial buildings can no longer adequately serve their original functions; as a result, idle or underutilized spaces coexist with the growing demand for new public services. After such functional changes are made, the original building dimensions (span, depth, floor height), as well as existing equipment conditions, often fail to directly accommodate the new usage patterns—particularly in terms of natural lighting, ventilation, acoustic environment, and facility capacity, where mismatches are common. How to reconcile the conflict between new functions and existing spaces within the constraints of limited demolition and renovation work has become a key challenge to be addressed in the interior renovation of existing buildings.

2. Indoor environmental characteristics of existing buildings in the old urban area

2.1 Significant spatial scale limitations

The existing buildings in the old urban area were largely constructed during specific historical periods; their bay width, depth, floor height, and room area often corresponded to their original

residential, commercial, or office functions, resulting in spaces with a strong degree of pre-established scale. Some buildings feature finely divided room layouts with limited continuous usable area; other street-facing buildings have considerable depth, with their internal spaces extending significantly in the longitudinal direction; traditional residential buildings and small public structures are frequently constrained by relatively low floor heights [1]. When building functions change, the range of human activity, furniture arrangement, and demands for public spaces also evolve; this can easily lead to a mismatch between the original spatial scale and the new usage intensity.

2.2 The existing structure has strong constraints

The existing building envelope represents a challenging boundary condition that cannot be easily circumvented during the interior renovation of buildings in the old urban area. In brick-concrete structures, the locations of load-bearing walls are relatively fixed, and the drilling of openings into these walls as well as the spatial connectivity are constrained; although frame structures offer a certain degree of openness, the column spacing, beam height, and floor slab configurations still influence the integrity of the space [2]. The original stairwells, vertical shafts and structural joints have been left as they are for a long time. When the new functional requirements need a larger continuous area or more complex circulation, it is not possible to arbitrarily modify the existing beams, columns and walls to meet the demands of these areas; the range of modification is much smaller than in newly constructed areas.

2.3 Significant Differences in Environmental Foundation

The internal environments of the existing buildings vary greatly depending on factors such as direction, distance from the road, floor level, etc. Rooms that face the outside generally have good natural light and are relatively bright; deep rooms inside are often dark, and if there are few windows or they are not positioned well, air circulation will also be poor. In some older buildings, the thermal insulation performance of the outer wall has decreased, so the indoor temperature will fluctuate more with the seasons; also, rooms near the street may be subjected to continuous traffic noise [3]. At the same time, due to long-term use, the lighting, air conditioning, electrical, water supply and drainage systems have become old and are unevenly distributed across the different areas.

3. Principles of Interior Environmental Design for Functional Adaptation of Existing Buildings in Old Urban Areas

3.1 Functional Adaptation Priority Principle

The assessment of the indoor environment after functional reconfiguration should be based on the new use of the space, not on the old function of the building or general environmental standards. When a residential area is designated as a community service area, changes will occur in the pattern of people's use, a certain degree of openness will be established, and there will be an increase in demand for public participation; Similarly, if an office or commercial building is changed into a cultural exhibition space, continuous adjustments need to be made in terms of space requirements, stable illumination and acoustics, etc. [4] Before the Design, it is necessary to consider factors such as the number of people using the space, the time of use, dynamic and static conditions, privacy needs, equipment load of the new function, etc., and to systematically evaluate how suitable the existing spaces and environmental conditions are for all these factors. The parts of the space that

can still be used for the new purpose should be kept, and those that are too different should be included in the adjustment plan. Thus, the following design will be based on the actual conditions of use and will not be a mere formalistic update of the function.

3.2 Moderate Intervention Protection Principle

The existing buildings in the old urban area bear upon them spatial relationships and structural traces formed over a long period of use; some beams, columns, staircases, walls, floors, and ceilings still remain suitable for continued use, and the original architectural scale characteristics as well as site-specific identification information may be preserved.

The first step in dealing with the existing items of functional adaptation is to determine their present state of preservation, use value and the extent of conflict with the new function. If the original components can still be used for the new activities without harm, then the current condition can be maintained or only necessary repairs need to be performed; otherwise, modifications should only be made when the components are detrimental to usability, safety or the environment. The scope of intervention should also be in line with the actual structural conditions of the building; do not carry out large-scale demolition based solely on the wish for full visual renewal, and do not replace all material elements in the original area that are still functional.

3.3 Principle of Environmental Performance Coordination

According to changes in function, many indicators of the indoor environment will vary with changes in use and location. An increase in the openness of a space will change the range of natural light, air flow and sound propagation; if the ceiling height is reduced because of equipment, then changes will also occur in the layout of lighting, the perception of space, and the local temperature environment; Changes in the materials of walls and floors will affect the amount of reflected light, sound absorption capacity, and heat. [5]Therefore, the assessment of light, heat, air circulation, noise and equipment conditions should not be carried out separately but should be considered together in light of the actual circumstances of use. If the improvement of one environmental indicator leads to a significant imbalance in other aspects, it should not be considered an appropriate outcome of space renewal; design decisions must take into account the interdependencies among different performance parameters as well as the actual usage conditions.

4. Indoor Environmental Design Methods for Functional Redevelopment of Existing Buildings in the Old Urban Area

4.1 Reconfigure spatial layout; integrate switching functionality

When undertaking spatial reconfiguration, it is advisable to first decompose the relocated usage activities into primary functions, auxiliary functions, and transportation functions, and then project the requirements for area size, dwell time, and interconnectivity associated with each type of activity onto the original building floor plan. Taking community service spaces as an example, one can first define distinct functional zones—such as reception, waiting, activity, consultation, and storage areas—where high-frequency-use spaces are located near the entrance and main staircases, while low-frequency auxiliary spaces are situated in areas with greater depth or less favorable natural lighting conditions. Some of the rooms need to meet the new functional requirements and should be retained to some extent; if there are too many non-load-bearing partition walls that excessively divide the space, some of these partitions can be removed and movable dividers will be employed to rearrange the area. Public Space Corridors: Based on the quantity of pedestrians, they

should have a width of about 1.2-1.5 metres; at corners and in areas with a high concentration of people, this minimum width may need to be increased; and a turning radius of about 1.5m × 1.5m should be left in places that need to be suitable for wheelchairs. If the current columns are not easy to move, they can be used as supports for service counters, display stands, and so on to save space.

4.2 Adjust the Light, Temperature and Sound Environment of the Physical Space

Natural light can be obtained by considering the existing window openings, the direction of the building, and its depth; first determine the areas where people will spend most of their time and then add artificial light in the other areas. The work-surface illuminance in Areas where people need to do sustained visual work, such as offices, reading rooms and consultation rooms, should be around 300-500 lux; in general communication and rest areas, it should be about 150-300 lux; and in corridors and other places, it is generally 100-150 lux. If the original building has few windows, low solid partition walls can be added to create upper areas that are still somewhat bright; in places where privacy is not required, light-diffusing materials such as frosted glass or long-horizon glass can be used to allow some natural light from outside in. If there is a large difference in brightness among the areas close to the windows and the far interior, adding more general ceiling lights is not a good solution; instead, zoned lighting control should be introduced to reduce the amount of artificial light in the window-adjacent area and increase local task lighting in the interior. To reduce the heat in the area around the west-facing window that is directly exposed to sunlight, adjustable shutters, roller blinds, etc., can be installed inside to prevent the heat accumulation caused by dark-coloured materials near the window.

4.3 Integrate Materials and Equipment, Optimise Indoor Interfaces

The treatment of the wall, ceiling and floor junction should start after completing the on-site zoning documentation and deciding whether to retain, repair or build anew. If the existing terrazzo, wooden floor or exposed brick wall is in good condition, first check for hollowing, cracks or moisture; if the damage is localized and repairable, do not have to remove the whole surface. The junction between new and existing flooring surfaces should, where possible, align with door openings, wall lines, or functional boundaries; within a single open space, the use of multiple fragmented material joints should be avoided. For new floor finishes, the threshold height, the first and last steps of staircases, and the height difference relative to the original floor surface must be verified; any localized elevation should be kept to a minimal extent. Prior to ceiling treatment, the clear height beneath the beams should be re-measured; for rooms where the original clear height is less than approximately 2.8 m, large-scale full-height ceilings should not be used – instead, equipment can be concentrated in corridors, along walls, or in localized linear areas. Where the original beam-slab relationship must be preserved, new lighting fixtures, sprinkler systems, and utility pipelines should be arranged along the beam span direction to minimize irregular intersections on the ceiling surface.

Equipment layout should first be coordinated based on the main distribution lines before determining the final installation positions. Systems such as air conditioning, fresh air supply, fire protection, electrical, low-voltage, and water supply/drainage systems may be overlaid and verified on both the floor plan and ceiling plan drawings; when air ducts, cable trays, or fire protection pipelines intersect, priority should be given to pipelines with larger cross-sectional areas, clearly defined slope requirements, or those that cannot be bent. In areas where floor height permits, a centralized equipment zone with a width of approximately 450–600 mm may be established to collectively accommodate air vents, lighting fixtures, sprinkler heads, and maintenance access points; where the original ceiling surface requires exposure, exposed pipelines should be arranged

in groups along beam or wall edges, with pipelines of the same type kept parallel. Maintenance access points should be reserved for components requiring maintenance—such as fan coil units, valves, and electrical distribution boxes; commonly used access points may be sized at approximately 400 mm × 400 mm or 600 mm × 600 mm, depending on the equipment dimensions, and should be positioned to avoid being obstructed by fixed cabinet units. The new bathrooms and toilets should be near the existing vertical pipe shaft, and if horizontal drainage is needed, the structural height, pipe size and required slope clearance should be decided upon in advance.

In short, the function adjustment of old buildings in the city centre is to meet the needs of the new era by changing how the space is used. Interior renovation should not be a total renovation; rather, it should respect the original structure and usable parts, making reasonable modifications to the space, improving the environment and upgrading facilities all at the same time. Only when there is an appropriate combination of functional changes, environmental conditions, and the original characteristics of the space can existing buildings be made suitable for new life, thus preserving the spatial value and distinctive character of old urban areas.

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