

Research on the Evolution and Design Strategies of Residential Spaces Based on Intergenerational Needs: A Case Study of Utetheisa Kong

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Abstract. At present, China is in a stage of profound changes in population structure and family patterns. The proportion of the elderly population continues to rise, and the number of the oldest-old is increasing day by day. Meanwhile, driven by traditional family values and the dual pressures of elderly care and childcare in reality, the multi-generational cohabitation lifestyle has become increasingly common. However, most current residential spaces still follow the previous design logic, failing to adequately respond to the differences in physiological characteristics, psychological states and daily behavioral patterns among members of different age groups. Such a lag in design often leads to low spatial utilization efficiency, and also easily triggers internal family conflicts due to different living habits, making it difficult to form a harmonious and livable family environment. To seek a more practical residential response approach, this paper first sorts out the residential demands of children, young and middle-aged people, and the elderly respectively. Children need a safe and inspiring growth environment; young and middle-aged people pay more attention to work efficiency and quality of life, and tend to have relatively independent private areas; the elderly focus on residential safety, convenient movement and opportunities for interaction with family members. In addition, three-generation cohabitation also has common needs for shared space and emotional communication. On this basis, this paper reviews the evolution of residential spaces in China. In the planned economy era, residences only aimed to meet basic survival needs; after the reform and opening up, public and private spaces began to be gradually separated; in the 21st century, although residential functions have become increasingly complete, they generally lack personalized consideration. Residential design has always been in a passive adaptation to social changes. In response to the challenges faced by intergenerational cohabitation in the new era, this paper puts forward corresponding design strategies for large-sized and small-sized apartments respectively. Large-sized apartments focus on keeping each functional area independent while facilitating connection; small-sized apartments emphasize the composite use and flexible adjustment of space. Meanwhile, the adaptability of space and the integration of intelligent technology are specially emphasized. It is proposed to improve the overall comfort and convenience of residence through adjustable layout and intelligent auxiliary means, aiming to provide operable optimization schemes for multi-generational cohabitation families, and promote harmonious intergenerational relations and family happiness.

Keywords: Intergenerational Needs, Residential Space, Design Strategies, Family Structure

1. Introduction

Under the combined effect of the intensifying aging trend and social and economic development, as well as the inertia of traditional culture and policy guidance, China's family structure has obviously evolved towards the multi-generational cohabitation mode. By 2020, the proportion of nuclear families and three-generation direct-line cohabitation families has exceeded 50%. However, traditional residential space design pays insufficient attention to intergenerational interaction, making it difficult to take into account the actual needs of all age groups, resulting in low efficiency and weak living atmosphere [1, 2]. Against the background of urban renewal, creating a safe living environment that promotes communication and eliminating intergenerational barriers is clearly the key to improving the quality of human settlements [1, 3]. There are differences in lifestyles and values among young and middle-aged people, children and the elderly, which are prone to conflicts in limited space. Examples show that traditional Chinese residential experience indicates that high density and high efficiency are not inevitably contradictory. The new residential concept should be people-oriented and inclusive of diverse life forms [4]. Systematic and meticulous spatial design strategies need to be introduced urgently to respond to policy orientations such as "aging-in-place renovation" and "child-friendly cities", promote the transformation of residences from physical construction to humanistic care, and thus improve the quality of public and private spaces in intergenerational families. Precisely meeting the needs of different age groups can not only respond to the spatial expectations of residents, but also provide a feasible path for real estate development and the renovation of existing residences. Especially for multi-generational cohabitation families, coordinating the demands of all generations within a limited area is actually a key problem that needs to be broken through at present.

Existing studies have pointed out that domestic design practices focus more on functional optimization and intergenerational integration in high-density environments, with concerns focused on structural transformation, technological reshaping and policy guidance; in contrast, relevant foreign explorations pay more attention to the diverse trends of personalized expression, green environmental protection concepts and technological application. In recent years, design research examples have also shown that the selection of materials for interior decoration should advocate green, environmental protection and health attributes, and the functional setting needs to take into account diversity and practicality.

This study aims to address the residential dilemmas caused by multi-generational cohabitation, so as to improve spatial comfort and ease internal family conflicts. Through literature review, the intergenerational needs, the evolution of residential spaces and the underlying driving forces can be analyzed. It can be seen that the lack of detailed spatial handling is likely to pose potential safety hazards to the elderly and children, and adversely affect the overall quality of life. Starting from an overall perspective and flexible choices, the concept of functional compounding should run through the whole process of spatial layout and facility configuration. Through an in-depth analysis of the physiological and psychological needs of people at different ages, a flexible and variable layout should be adopted to adapt to the switching needs of multiple life scenarios. The potential conflicts in intergenerational relations — such as between parents and children, and between grandparents and grandchildren — also need to be clarified, so as to promote the space to maintain independence while retaining necessary connections and have the potential for dynamic adjustment [5]. Only in this way can the spatial utilization efficiency be effectively improved, so that each family member can not only enjoy an independent private area, but also maintain smooth communication, and respond to differentiated demands in details. Combined with the concept of sustainability and green design orientation, it can further promote the ecological evolution of interior design. Finally, through

the analysis of spatial planning strategies in typical successful cases at home and abroad, the practical feasibility of the path proposed in this study can be verified, the deficiencies of existing studies can be made up, the division of residential spaces can be made more scientific and reasonable, the diverse needs of family members can be fully responded to, and the harmonious development of family relations can be promoted.

2. Analysis on the evolution of residential spaces based on intergenerational needs

Looking back to the 1960s, on the basis of learning from the Soviet model and combining with national conditions, China established residential components including bedrooms, kitchens and toilets, which could only meet basic survival needs. By the late 1970s, during the planned economy period, residential design still took bedrooms as the absolute core, and there was no concept of public-private zoning in each functional space [6]. This situation was broken after the Third Plenary Session of the 11th Central Committee in 1978. The reform and opening up brought a leap in society and technology, and family values were reshaped accordingly. Since the end of the last century, with a large number of only children entering the parenting stage, the number of family generations has risen periodically, prompting the traditional multi-generational household model to become the core consideration of residential unit design again [7]. With the dual leap of economy and technology, residential supporting facilities have become increasingly perfect, two or three bedrooms with one living room have become the mainstream, and each functional space has been independent. In the 21st century, the residential construction model has become more diverse, not only realizing the effective separation of public and private, dining and sleeping, living and sleeping, as well as clean and polluted areas, but also the spatial composition has become more systematic and complete [8]. According to the family life cycle theory, three-generation families can be divided into three core stages: "youth growth", "middle-age maturity" and "old-age expansion" [9]. The differences in living needs and habits at different stages directly lead to the evolution of housing type demands. For example, middle-aged and mature families mostly prefer large-sized apartments such as 3 bedrooms, 2 living rooms and 2 bathrooms, while young and growing families prefer compact layouts such as 2+1 bedrooms, 2 living rooms and 2 bathrooms [10]. (As shown in Figure 1, Figure 2 and Figure 3 below) Therefore, the design standards of each functional space also need to be adapted to local conditions.



Figure 1. Schematic Diagram of a Three-Generation Young Family



Figure 2. Schematic Diagram of a Three-Generation MiddleAged Family Structure



Figure 3. Schematic Diagram of Three-Generation Cohabitation in a Mature Family

From the perspective of lifestyle, its impact on residential interior space mainly covers four dimensions. Production methods (such as the iteration of tools and construction technology) and social status jointly dominate the macro evolution of residential types; daily living needs and individual preferences directly determine the logic of interior functional zoning; comfort and aesthetic images guide the design trend of interior interfaces; and physiological needs and behavioral activities promote the iteration of furniture. The shaping effect of lifestyle on residential space is obviously stronger than the reverse influence of the latter on the former [8]. Starting from this, residential spaces are divided into three categories: public, private and service, and their evolution characteristics are sorted out. In terms of public spaces, the changes in demands are mainly presented in the following three points: first, special attention is paid to spatial availability, and the efficiency of the living room is often improved by tapping the value of areas such as the porch and corners; second, flexible activity areas are reserved, and flexible spaces are allocated

through functional integration; third, the transformation of entertainment modes promotes the traditional entertainment space to a functional area with better atmosphere and easy maintenance. The evolution of private spaces is concentrated in five dimensions: the function of bedrooms is expanded, and audio-visual or study functions are integrated into them to enhance the private experience; the spaciousness of the space is improved, and built-in wardrobes replace independent dressing rooms as a common practice; flexible interchange between elderly rooms, children's rooms and guest rooms is realized to respond to changes in the family life cycle; functional superposition occurs between studies, tea rooms and other spaces; the function of bathrooms is further refined, and storage or washing machines are added to enrich their service functions [11]. The changes in the demand for service spaces focus on three directions: the integrated design of kitchen and dining not only expands the operating vision, but also transforms this area into the core field of family communication; storage space tends to be invisible, independent storage rooms are cancelled, and walls or cabinets are used for built-in storage; the function of balconies is becoming increasingly diverse. With the popularization of drying equipment, the demand for drying is reduced, and balconies are gradually evolved into spaces carrying leisure and entertainment value [11].

3. Theoretical basis of intergenerational needs and residential spaces

3.1. Differentiated residential space demands of different age groups

3.1.1. Children

According to the definition of the international *Convention on the Rights of the Child* in 1989, "a child means every human being below the age of eighteen years unless under the law applicable to the child, majority is attained earlier" [12]. This age range spans a large period, and children at different growth stages have obvious differences in the demand for residential spaces. Children in infancy (0-3 years old) mainly explore the world through perception and movement, with a focus on companionship and safety. Therefore, they have high safety requirements for spaces, and are more suitable for spacious ground activity areas and open vision, forming a play-learning integrated space [12]. Children in early childhood (3-5 years old) still have a high demand for spatial safety, but with physical and psychological development, their activity scope is further expanded. Therefore, on the premise of ensuring safety, they need spaces that support independent movement and independent sleep, and provide places for interactive games with peers or parents [12]. Children in school age (6-12 years old) are more mature in all aspects than the previous two stages, and their attention to spatial safety gradually weakens. They tend to have relatively independent spaces, and at the same time, with academic needs, they need to be equipped with learning areas. Children at this stage grow rapidly and are curious. Spatial design should be rich in levels and interesting to stimulate their desire to explore [12]. Adolescents (13-18 years old) are in puberty, with significant changes in body shape and behavior. They have higher requirements for privacy, need exclusive learning spaces, and also have a corresponding increase in demand for storage spaces to facilitate the organization of daily and school supplies [13].

3.1.2. Young and middle-aged groups (18-59 years old)

For the relatively young youth group (18-40 years old), most of them are in the rising period of their careers, active in heart, eager for changes, and have a wide range of interests. For the youth group aged 18-40, who are in the career development stage, active in heart, eager for changes and with a

wide range of interests, their demand for space focuses more on individuality, diversity and fun [1]. In view of their frequent social activities, spatial design should take into account openness and privacy. At the same time, the youth group attaches great importance to the safety and health of space, which helps them establish a strong sense of security and belonging [1].

With the increase of age, the relatively older middle-aged group (40-60 years old) often needs to face and bear more responsibilities for supporting the family, taking care of the elderly and children in family life. Therefore, their demand for space is different, and changes to a certain extent according to family conditions. Due to the need to take care of daily life, this age group has a relatively high utilization rate of kitchens and bathrooms in the family, so the kitchen and bathroom spaces should have high adaptability for this age group. At the same time, to better take care of the vulnerable groups in the family, there is a high demand for smooth vision and moving lines in the space [13]. With changes such as children growing up, the demand of this age group for residential spaces should also restore or increase their personal needs, such as having personal private spaces and entertainment spaces [13].

3.1.3. Elderly group (over 60 years old)

With the increase of age, the degenerative changes of human muscles, organs and bones have a significant impact on the daily life of the elderly, so their perception of many aspects of life will decline. Therefore, the demand of this age group for residential spaces focuses on a safe and comfortable elderly care environment. In terms of space, they need a fixed residential space, and at the same time, the smoothness of the space and aging-friendly design can effectively improve the safety, adaptability and sense of security of the elderly in home life [14]. At the same time, affected by hormones and other factors, the elderly are prone to unstable emotions. Therefore, the space also needs family companionship or entertainment spaces to alleviate negative emotions such as depression [15].

3.2. Common residential space demands of family members in intergenerational cohabitation scenarios

Residential spaces include bedroom spaces, bathroom spaces, living spaces, kitchen and dining spaces, balcony spaces and other additional spaces. Public spaces in the family include living rooms and dining rooms [15]. The living room is mainly used for receiving guests, entertainment and reception, and is also the main place inside the family [16]. Specifically, modern family spaces should have high adaptability and variability to respond to changes in family structure and member needs. For example, when a family welcomes a newborn, the space needs to be endowed with the function of a children's activity area. As children grow to school age, their demand for independent activity spaces may decrease. At this time, the original children's activity area can be reduced, so that the attribute of the entire space gradually returns to a more single or adult-oriented function, such as a study or leisure area [2]. Therefore, this space should mainly meet the requirements of interactivity. Spaces for family members to interact and communicate can make family members care and understand each other and convey feelings [15]. In the design of kitchen space demand, starting from ergonomics, aiming to improve the utilization rate, layout rationality and streamline rationality of kitchen space, the overall design of kitchen space should be paid attention to by comprehensively considering its plane layout, area size, etc., so as to improve the long-term effective use of kitchen space [17]. Therefore, the spatial and adaptive design of the kitchen should be more inclined to meet the needs of middle-aged people who are mainly responsible for cooking

in the family and the elderly who help take care of children, such as convenient access to storage space in the kitchen and procedural operation. The bathroom is the area with the largest number of users, the highest frequency of use and the highest overlap rate of use spaces in the entire residential space. Bathrooms generally include toilet space, bathing space, washing space and housework space. Therefore, this space should ensure higher privacy and ergonomic size settings and use [17]. The study provides functions for people to read, work and talk. This space should be quiet and have a good lighting system [16]. It can provide a place for middle-aged people who sometimes need to work, students who need to study or leisure reading. The bedroom space plays an important role in the entire residential space. The main demand of all residents for bedroom space is a space with high autonomy and privacy where they can relax, rest and free themselves. In a residence, efforts should be made to ensure that residents have their own independent spaces without interference [17].

4. Design strategies of residential spaces based on intergenerational needs

4.1. Large-sized residential spaces

Three-bedroom apartments are large-sized apartments in old communities. As shown in Figure 4, although the area is neat, the moving line of the living room is chaotic, and family members are easily disturbed when interacting in the living space. Therefore, the door openings of the three bedrooms can be moved to the edges, as shown in Figure 6, to ensure that the living space is a pocket space, so that the two spaces form a pocket-shaped family core interactive space that is connected with each other and not disturbed by activity moving lines [10].

At the same time, with the improvement of economic level, although large-area units are conducive to improving residential comfort, combined with China's national conditions and the survey on the residential willingness of the elderly, at present, two to three bedrooms with an area of about 100 square meters are more in line with the residential needs of the elderly and children. As shown in Figure 5, for larger spaces, the area can be appropriately allocated from other spaces to increase the area of the master bedroom and the elderly room, and improve the activity space and comfort of intergenerational groups [18]. In addition, for larger residential spaces, a suite layout can be considered to reduce life interference and ensure the quality of life of each generation [19]. The residential demand of young couples can be mainly met by lighting demand. Therefore, in the spatial layout, if the elderly need to be taken care of, the elderly room and the room of young couples can be set nearby for convenient care [20].



Figure 4. Original Spatial Layout of Large-Sized Residential Units

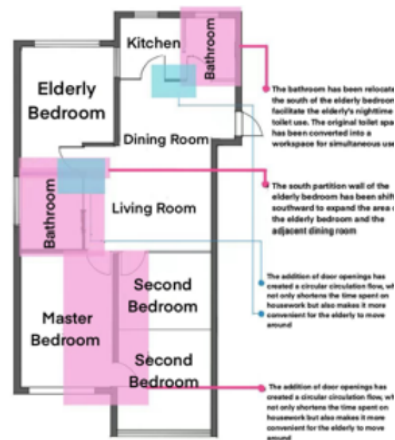


Figure 5. Research on Spatial Layout Optimization of Multi-Generational Cohabitation in Large-Sized Residential Units

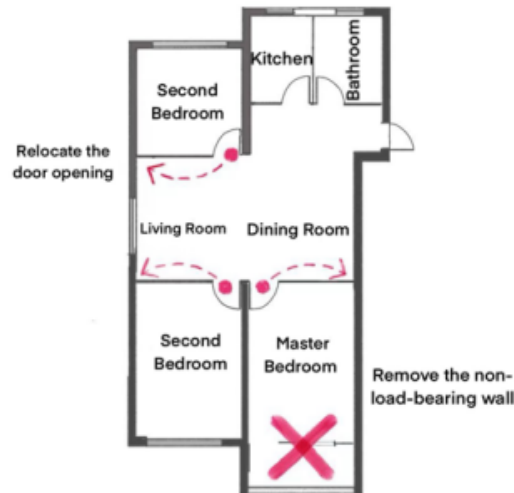


Figure 6. Schematic Diagram of Optimized Moving Lines of Living Space in Large-Sized Residential Units

4.2. Small-sized residential spaces

For residential spaces with one or two bedrooms, as shown in Figure 7, the space is small in area, which is prone to problems such as poor lighting and insufficient storage space. For these problems, the space area can be expanded by integrating the space, and sunlight can be introduced into the room by opening up the space to enhance the spatial lighting effect. In addition, the space aisle should be expanded to meet the daily use of elderly in wheelchairs, reducing obstacles to secondary renovation in the later stage. For smaller residential spaces, spatial division and sight shielding should also be done well. Bookshelves and storage racks can be used as semi-open partitions, so that they can not only retain a sense of permeability but also form psychological boundaries [19]. Defining residential spaces in a modular way can effectively optimize residential spaces and improve indoor space utilization efficiency. By integrating relevant functional spaces, the adaptability of residences can be improved to meet the needs of different groups [13]. In addition, a large bay structure should be formed as much as possible, load-bearing walls and columns should be

reduced as much as possible in the design, as shown in Figure 9, and beamless large floor slabs should be adopted. Moreover, the outline of the main structure should be regularized, and the concave and convex of the outer contour wall should be reduced, as shown in Figure 8, to create a concentrated and complete usable space. This can improve the flexibility and comfort of spatial layout, facilitate construction, and meet the requirements of energy saving, land saving and material saving in adaptive design [21]. At the same time, a certain space should be reserved as a mobile space for residential spaces to adapt to the spatial requirements of family member changes [22]. Meanwhile, although the structural integrity of load-bearing walls is crucial, it is feasible to add door openings in them to improve spatial moving lines and connectivity through accurate engineering analysis and appropriate reinforcement technologies [23, 24]. This practice aims to balance structural safety and residents' demand for flexible spaces.

In the space at the nuclear family stage, for families with only one child, the larger bedroom can be used as a children's bedroom, and divided into a rest and sleep area and a multi-functional space, which can meet the needs of parent-child interaction, children's activities and temporary residence for family members or friends. For families with a two-child plan and families with young children, the master bedroom can be first used by the couple, and the usable area of the couple's bedroom can be expanded to facilitate the care of children in the early stage. Later, the functions of the master and secondary bedrooms can be replaced, and double children's bedrooms can be set in the master bedroom space. At the same time, a loft bed with a desk can be adopted to ensure space for study and rest, and wardrobes can be used as partition walls to ensure privacy [10].



Figure 7. Research on Original Spatial Layout of Small-Sized Residential Units



Figure 8. Comparison of Regularized Outer Contour Design of Small Spaces



Figure 9. Comparative Analysis of Load-Bearing Structure Design of Small-Sized Residential Units

4.3. Spatial adaptability

As an important communication space in the family, the comfort of the living room can be adjusted by changing the size and distance of furniture [22], so as to improve the comfort at different ages. In addition, the dining room can be connected with the living room to make the space more open and facilitate visual communication [22]. A children's activity space can be set in open areas such as the living room to meet children's playful nature. Protective fences can be installed in high-risk areas such as windows and balconies, and sockets can be set in positions not easily accessible to children, and protected door sockets can be used to ensure children's safety [19].

The area of the kitchen can be appropriately expanded, and the width of the aisle should be widened accordingly to adapt to the actual needs of multi-generational shared use. In addition, the kitchen can be divided reasonably to fit the differences in diet and living habits of different generations [22]. The kitchen and dining room should be arranged adjacently, so that the walking path required by the elderly can be shortened, and the risk of scalding for the elderly and children during food delivery can be reduced. This practice is consistent with the aging-friendly residential design principles advocated in many studies, aiming to improve the safety and daily convenience of the elderly at home [24]. The bathroom space should realize dry-wet separation as much as possible, and carry out clear functional zoning to facilitate the collaborative use of multiple generations [25]. In terms of spatial function organization, elderly bedrooms should be arranged centrally to make it easier to reach areas such as bathrooms, dining rooms and living rooms, especially the bathroom must be adjacent to the elderly's residence. If there are two bathrooms in the apartment, the elderly can be arranged to live in the bedroom equipped with a bathroom [20]. In the home environment design for the elderly, grab bars are often installed in key positions such as bathrooms and porches to provide posture support, strengthen physical balance, and assist in the transfer and movement when using the toilet, bathing or entering and exiting the door. This practice has become a conventional method in elderly environment design and aging-in-place strategies, aiming to reduce the probability of falls through environmental transformation, and improve the quality of life and independent ability [26].

On the whole, an intelligent control system can be introduced into the residential space, and the unified control of the whole house's lighting, furniture, air conditioning and other equipment can be realized through means such as intelligent touch panels. The elderly and children in the family can also be set as key care objects, and the system can send out early warnings in time in case of emergencies. In addition, various intelligent devices can be used to monitor indoor environmental parameters or residents' health status. Through careful consideration of color, material, furniture layout and other aspects, personalized design can be carried out for different residents in each functional space, so as to enhance their sense of identity and belonging to the residence.

5. Conclusion

To sum up, in the residential space design under the background of multi-generational cohabitation, this paper systematically sorts out the differences and commonalities in the needs of children, young and middle-aged people, and the elderly, analyzes the evolution process of residential spaces in China from meeting basic functions to clear public-private zoning, and then to the need for spaces to adapt to intergenerational needs. Combined with the spatial characteristics of large-sized and small-sized apartments and intergenerational cohabitation scenarios, design strategies such as spatial moving line optimization, functional composite integration, aging-friendly and child-friendly detailed design and integration of intelligent systems are carried out. By summarizing and analyzing the problems such as spatial conflict, privacy protection and safety adaptation faced by current multi-generational families in residence, it also provides realizable design schemes for housing type planning of real estate development and residential upgrading and renovation. Moreover, in the future construction of multi-generational family residences, continuous deepening should be carried out, the needs of residents should be fully considered, and continuous exploration should be made in functional adaptability, spatial flexibility and emotional connection, so that the family space can be used more efficiently and comfortably. So as to better meet the residential needs of different intergenerational families, provide a comfortable living environment for residents and promote family harmony.

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