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Lifelong Residence Oriented Home Design for Autism Spectrum Disorder Informed by Spatial Foreshadowing and Predictability

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Abstract: *Autism spectrum disorder (ASD) is an early onset neurodevelopmental condition whose influence often extends across the life course, including persistent differences in social communication, repetitive behavioral patterns, and atypical sensory modulation. For many autistic people, support remains necessary in adulthood; consequently, co residence with family and long term caregiving become common living arrangements. In this context, housing functions as everyday care infrastructure: circulation clarity, the controllability of sensory triggers, and the foreseeability of spatial relationships may shape routine emotional stability and behavioral organization, while also affecting caregivers' workload and recovery margins. Existing design discussions related to ASD have largely focused on rehabilitation and special education settings, whereas ordinary co residential housing is often treated through general recommendations rather than a derivable and transferable spatial model. To avoid conflating spatial claims with clinical efficacy, this paper is positioned as conceptual design research. It synthesizes needs and literature informed insights, translates principles into spatial control logics, develops a conceptual spatial scheme, and checks internal coherence through scenario based validation using a daily routine script. The contribution is an operational framework linking low stimulus variable management, spatial foreshadowing for route legibility and predictability, function first organization with scripted use, and a replicable site selection model, offering a practical pathway for healing oriented residential design for ASD families.*

Keywords: *Conceptual design research, Inclusive design, Spatial experience, Spatial foreshadowing, Predictability, Healing oriented housing, Autism spectrum disorder*

1. Introduction

Autism spectrum disorder is widely recognized as an early onset developmental difference that can influence social interaction and behavioral organization across the lifespan. In many regions, adult services and community support remain limited; as a result, sustained family caregiving and co residential living become pragmatic, long term arrangements. Under these conditions, the home is not only a setting for daily life but also continuously running care infrastructure. The intelligibility of circulation, the extent to which sensory triggers can be moderated, and the degree to which spatial relations are foreseeable can shape everyday emotional regulation and behavioral stability, while also redistributing caregivers' time costs and recovery margins.

Architectural responses to ASD have tended to prioritize short cycle, intensive intervention environments such as rehabilitation facilities and special education buildings. At the scale of housing, many proposals remain principle driven and difficult to operationalize, offering limited guidance on how a spatial model can be derived, reused, and adjusted across cities. To prevent design strategies from being interpreted as clinical claims, this study adopts the stance of conceptual design research. Needs synthesis and literature informed insights are consolidated into a design proposition, translated into spatial control logics, developed through a conceptual scheme, and examined through scenario based validation using a daily living script. The focus is to reduce environmental uncertainty, lower caregiving friction, and sustain predictability in long term use rather than to assert medical causality regarding symptom change[1-2].

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2. Behavioral Characteristics of ASD and Residential Needs

2.1. Sensory Modulation Differences and Environmental Sensitivity

Sensory modulation profiles among autistic individuals are heterogeneous. Residents may experience heightened sensitivity, reduced sensitivity, or active sensory seeking across modalities such as light, sound, touch, and visual information density. In domestic environments, cumulative factors such as glare, flicker, abrupt luminance contrast, reflective finishes, and visually complex textures can become persistent stressors. These conditions may be experienced as excessive informational load and can be associated with tension, avoidance, or repetitive behaviors.

Accordingly, the core objective of ASD family housing is not stylistic minimalism as such, but the establishment of a stable perceptual baseline through controllable parameters. Limiting glare and hard contrast, reducing unnecessary visual noise, and preventing long term occupation of surfaces by disordered objects can help keep the environment learnable, dependable, and less likely to produce abrupt sensory peaks.

2.2. Reliance on Order and the Need for Predictability

Beyond sensory sensitivity, many autistic residents show a stronger reliance on order and fixed patterns. When spatial semantics are legible, sequences are stable, and routes can be grasped in advance, residents are more likely to develop a sense of safety and accumulate spatial memory. Conversely, ambiguous functional boundaries, abrupt turns, and highly branched circulation increase situational uncertainty and can intensify anxiety and avoidance.

For long term co residence, predictability therefore needs to be embedded at the structural level of housing. The dwelling should support inference about what comes next and what typically happens there, allowing routine actions to consolidate into a stable living script through repetition.

2.3. Dual Needs under Co Residential Caregiving

Lifelong co residence requires housing to serve two interdependent systems of needs. For the autistic resident, priorities often include low stimulus, order, and predictability. For caregivers, priorities include caregivability, recoverability, and the preservation of ordinary family life. A design that over emphasizes isolation may reduce stimulation but can weaken interaction and raise caregivers' psychological burden. A design that is overly open may encourage interaction but risks importing excessive stimulation and amplifying behavioral conflict.

A balanced stance is controlled openness. The aim is to maintain necessary connection while filtering overstimulation, and to provide hierarchical buffers for retreat, observation, and recovery so that support can occur without repeatedly destabilizing the overall order of the home[3-4].

3. Principles and Translation for Lifelong Residence Oriented Housing

3.1. Low Stimulus Control from Stylistic Restraint to Variable Management

A low stimulus environment should not be reduced to less design. Under a lifelong residence orientation, it is better treated as systematic organization of stimulus variables and threshold management aimed at limiting stimulus peaks and reducing uncertainty. In ASD family housing, sudden shifts in daylight, reflective glare from materials, dense textures, and persistent object exposure can accumulate as sensory load; low stimulus therefore functions as a maintainable control strategy rather than a short term aesthetic preference.

Lighting stability is pivotal. The target is not maximal brightness but foreseeable illumination: avoiding direct glare and harsh contrast, building softer luminance gradients through diffuse daylight and more even illuminance, and keeping day night transitions continuous rather than abrupt. In parallel, interior information should be hierarchized. Decorative noise is suppressed while purposeful orientation and functional signals are retained so that space remains readable without becoming visually demanding. Interface continuity further reduces jump cuts in experience. Rounded corners, smoother transitions, fewer sudden directional breaks, and long term storage discipline help preserve environmental consistency and support everyday emotional regulation.

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3.2. Spatial Foreshadowing for Route Legibility and Situational Predictability

Spatial foreshadowing refers to the capacity of a space to provide advance cues through sightlines, light, or sequencing about the direction, boundary, and functional meaning of the next space while one is still in the current one. In a lifelong residence, foreshadowing is not merely experiential; it directly supports predictability. When residents can anticipate the next step, movement tends to become more continuous and uncertainty driven hesitation is less likely to dominate routine circulation.

To keep the concept design operational, foreshadowing can be treated as an inspectable set of attributes. Key nodes should be visible before entry, decisions at turns should require low cognitive cost, and major functional zones should maintain relatively stable positions within the overall sequence. In practice, a recognizable living core can function as a whole house reference, turns can be softened through buffer spaces or gradual shifts in scale, and a stable lighting logic can cue direction and hierarchy without adding informational noise.

3.3. Function First Organization and Scripted Use for Long Term Operation

Lifelong residence demands multi year usability and low cognitive burden. For ASD family housing, stability is not only a matter of material durability but also of consistent spatial semantics and rules of use. When zoning changes frequently or spaces are highly multi purpose without clear boundaries, residents' learning costs rise and caregiver intervention becomes more frequent and more exhausting.

A function first approach favors durable zoning semantics, a limited number of primary routes, and stable placement of key objects. Scripted use is proposed as an operational principle: time arrangements consistently map onto specific locations and sequences, allowing daily life to solidify into a repeatable rhythm. Discreet intervention points near the living core and buffer positions at private zone thresholds can enable observation, de escalation, and short recovery without repeatedly disrupting the overall domestic order[5-6].

4. A Replicable Site Selection Model Adaptable Across Cities

A lifelong residence housing model requires a site selection logic that is not tied to a single plot. This study summarizes such logic as near care, quiet stable, and continuous interface. Near care indicates practical access within a daily activity radius to comprehensive medical or rehabilitation resources that can support follow ups and contingencies while also providing psychological assurance for families. Quiet stable prioritizes distance from high intensity traffic corridors and complex nodes to reduce noise and information density. Continuous interface favors neighborhoods with relatively stable streetscape cues and functional composition, facilitating spatial learning and reducing uncertainty associated with rapid environmental change. The model can be tuned locally through parameters such as distance thresholds, road hierarchy, and interface complexity.

5. Spatial Composition and Design Development

The conceptual scheme develops the dwelling through massing operations that clarify spatial hierarchy and establish predictable relationships among private zones, the living core, and the activity release area. The design reasoning is summarized through a generation diagram that traces how program modules, spatial transitions, and light organization are coordinated to support low stimulus control and foreshadowing.

5.1. Hierarchical Zoning Organizing Spatial Semantics around Caregiving Relations

The program is organized into four modules: caregivers' private space, the autistic resident's private space, a family living core, and an activity release area (see Figure 1). The critical issue is not the number of rooms but the stability of spatial semantics and hierarchical relations. Private zones support rest, emotional recovery, and self settling under controllable stimuli. The living core functions as a reference point that helps residents infer orientation and sequence. The activity release area accommodates higher intensity movement and emotional discharge, limiting the diffusion of disturbance across the dwelling. This hierarchy aims to reduce cognitive load created by functional ambiguity and to lower caregiving friction through predictable spatial roles.

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The scheme is further clarified through plans, elevations, an axonometric view, and a decomposition diagram, which together communicate the logic of zoning, circulation, and structural support for open shared space (see Figure 2).

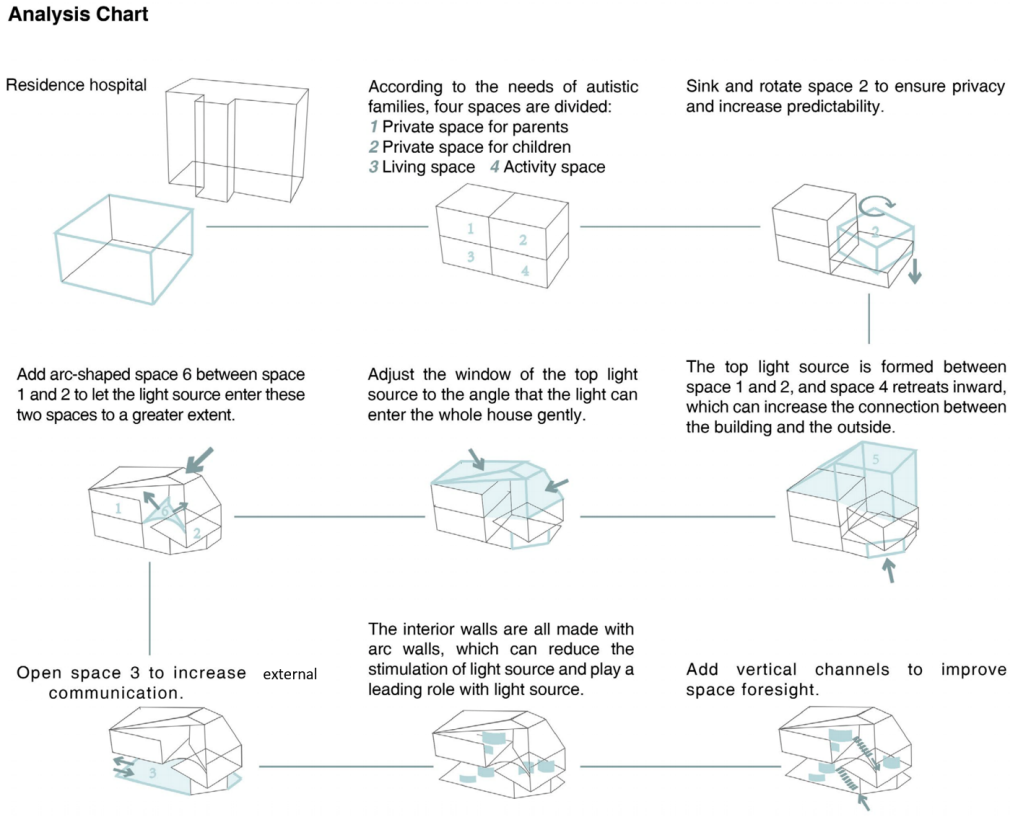

Figure 1: Strategy analysis diagram.

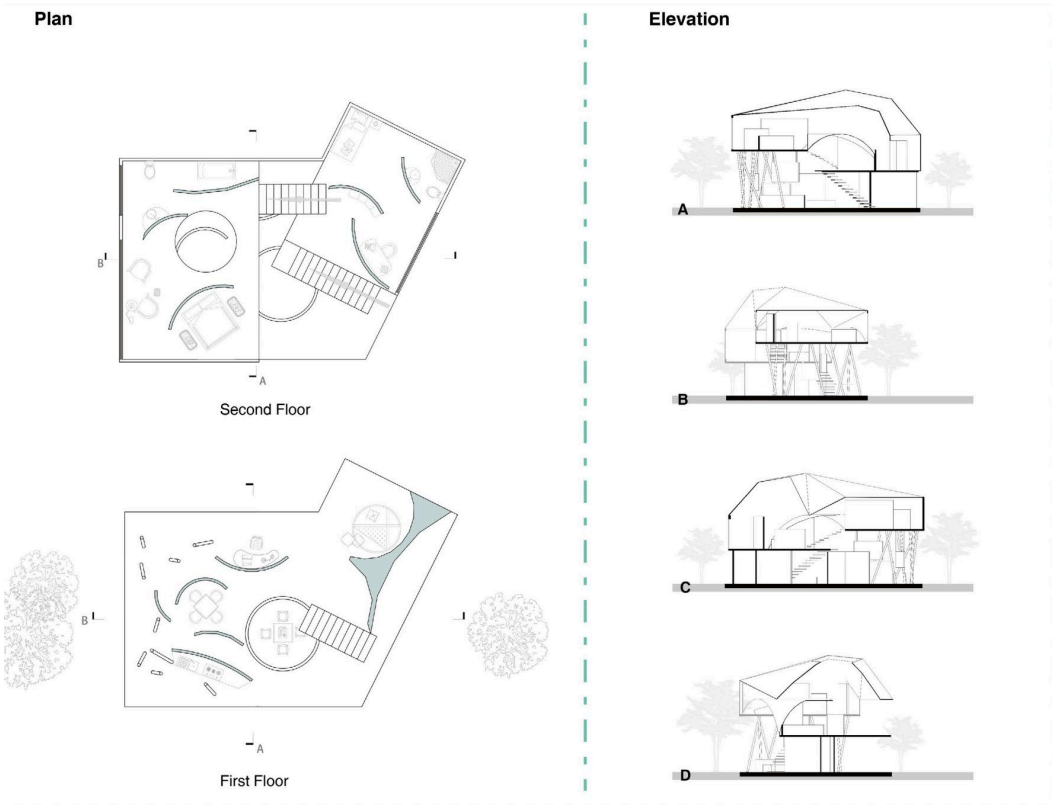

Figure 2: Plans, axonometric view

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5.2. Private Space Strategy Calibrated Separation with Necessary Linkage

The resident's private zone should provide safety without becoming fully isolating. Calibrated separation can be achieved through level differences, a buffer vestibule, or gentle directional shifts, while maintaining perceptible linkage to the living core. Such linkage allows the resident during self settling to sense family presence without direct exposure, reducing distress associated with abrupt separation. Spatial changes are handled as continuous transitions, avoiding excessive door openings and sharp corners that create abrupt contextual shifts.

For caregivers, private space should support not only sleep but also short retreat and emotional recovery. Accessibility should enable timely support while preserving calmness and privacy, so that intervention and recovery can occur without repeatedly destabilizing shared routines(see Figure 3).

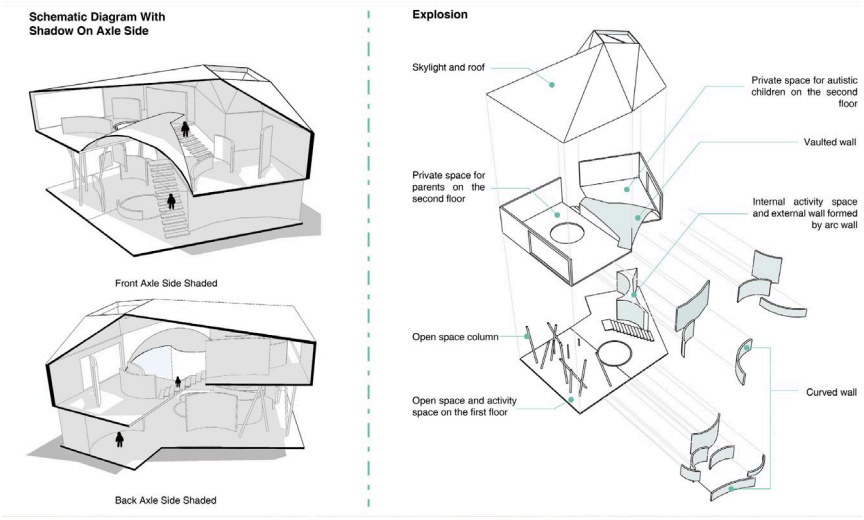

Figure 3: Decomposition diagram.

5.3. Interface Form and the Light Environment Reducing Stimulus Peaks through Continuity

Curved or rounded interfaces soften tension associated with sharp corners and reduce the likelihood of hard shadows and high contrast. Continuous surfaces also offer subtle directional cues during movement, strengthening sequence legibility. Daylighting follows a top light diffusion gradient logic. In the massing derivation, junctions between volumes generate a stable overhead daylight source. Openings are calibrated in geometry and incidence path so that daylight enters softly and spreads more evenly across primary activity areas, reducing glare and preventing jumping light patches(see Figure 4).

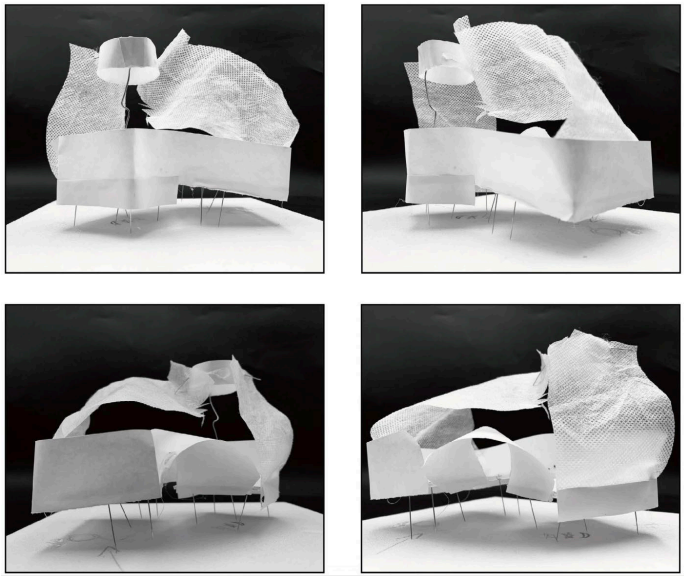

Figure 4 Manual model derivation diagram

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A curved transitional zone between adjacent areas enlarges the diffusion range of daylight and supports a continuous luminance gradient. In this way, interface continuity and lighting stability operate as a coupled mechanism. The section drawing illustrates the top light entry path, the buffering effect of curved inner surfaces, and the continuous inter level experience supported by light guidance.

5.4. Controlled Openness in Shared Spaces Connecting Inside and Outside While Filtering Stimulation

Shared spaces must enable family interaction while preventing external stimulation from dominating interior routines. Controlled openness is achieved through setbacks, semi transparent boundaries, controllable apertures, and filtered sightlines, allowing contact with the outside without surrendering interior order to external information density. Vertical circulation prioritizes clarity and visible association so residents can anticipate inter level relations without complex route finding.

The perspective view visualizes this controlled openness as a moderated threshold between domestic routines and the surrounding outdoor interface, supporting connection while protecting predictability in daily use (see Figure 5).

Figure 5: Perspective view of controlled openness and external interface.

6. Scenario Validation and Discussion

To check whether the strategies operate coherently, the scheme is reviewed through a scripted daily sequence. Meals and family interaction are concentrated in the ground level dining and living spaces; learning activities primarily take place in the upper level child zone; physical activity is located in the ground level activity area; and evening routines maintain low intensity contact with the outdoor interface, before night time rest returns to the respective private zones.

This sequence creates a stable mapping among time arrangement, spatial location, and activity type. The validation serves as an internal consistency check of the match between spatial organization and daily order rather than an inference about clinical outcomes. It indicates that predictability emerges from alignment among light, interfaces, transitions, and functional semantics through repeated use (see Figure 6).

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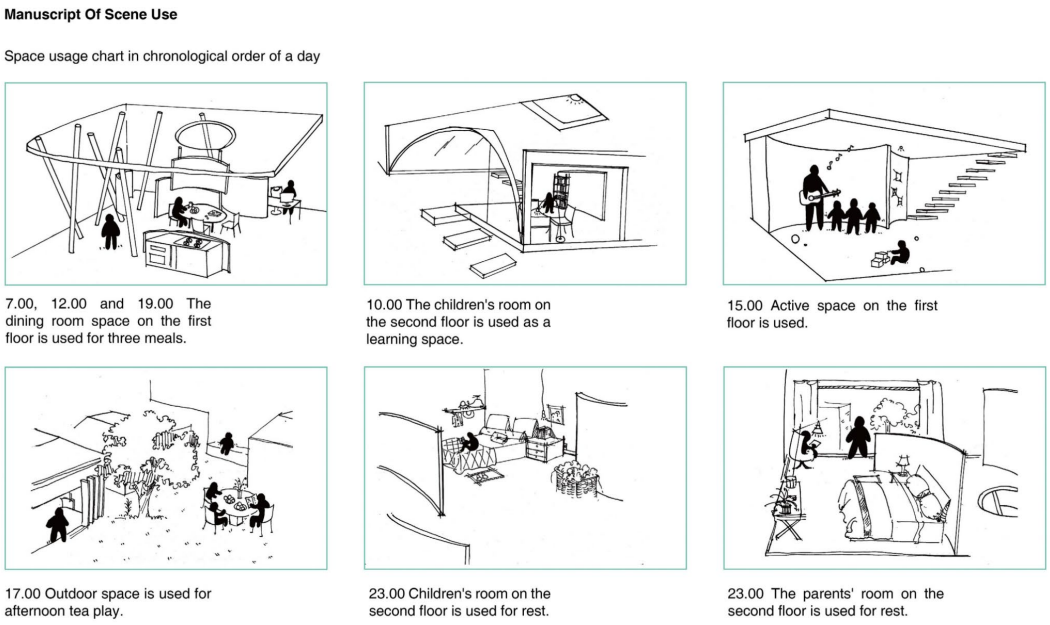

Figure 6: Daily routine script and time sequence use scenarios.

7. Conclusion

From a lifelong residence perspective, this paper develops an operational framework for co residential housing serving ASD families by translating three principles low stimulus variable management, spatial foreshadowing, and scripted use into spatial strategies. The claim is intentionally restrained. Rather than attributing therapeutic outcomes to architecture, the framework argues that spatial structure can sustain predictability in everyday life by moderating sensory peaks, clarifying routes, and reducing recurrent friction in caregiving routines.

The design contribution is fourfold. Low stimulus is treated as variable management rather than a stylistic label. Spatial foreshadowing is rendered inspectable through visibility, decision clarity at transitions, and stability of functional sequence. Function first organization is linked with scripted use to support multi year operation, including provisions for caregiver intervention and short recovery. A replicable site selection model is proposed that can be tuned through practical parameters across cities.

This study is conceptual and scenario validated. Future work may strengthen the framework through design led evaluation and post occupancy inquiry, including behavioral mapping, interviews, and participatory feedback with families, complemented by environmental measurements when appropriate.

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