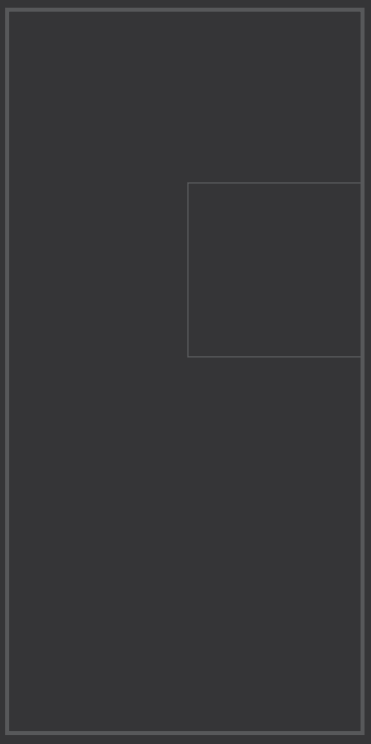
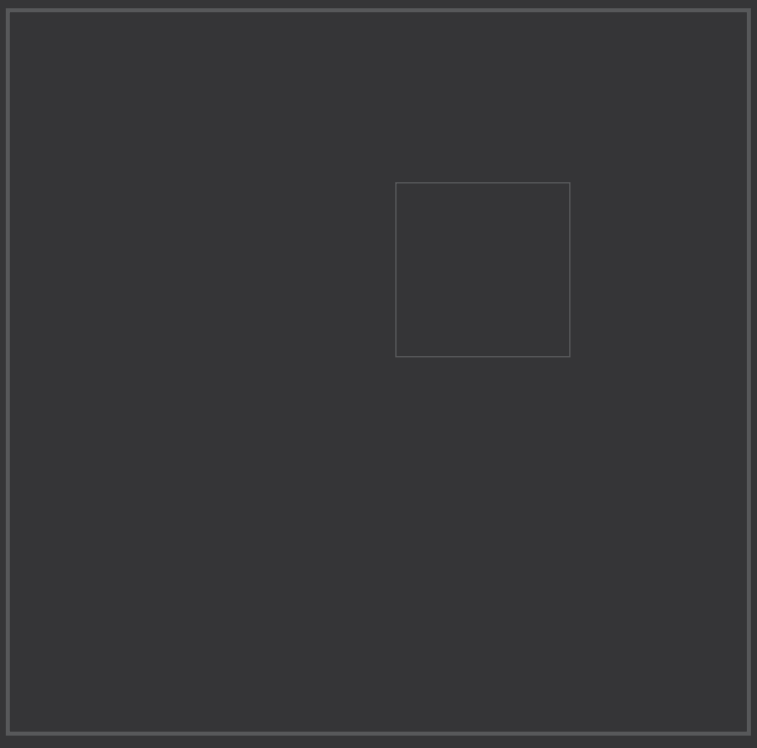
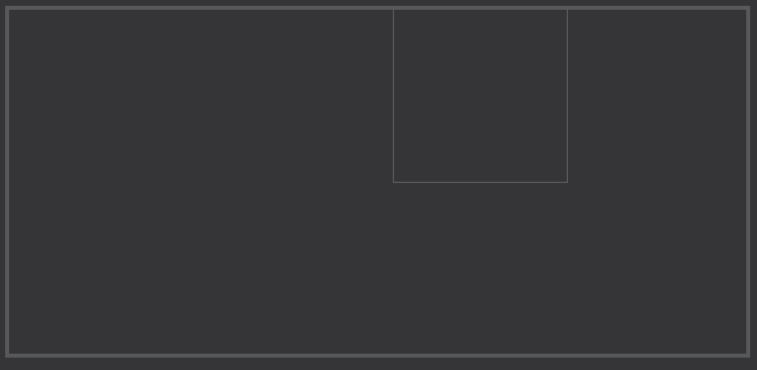
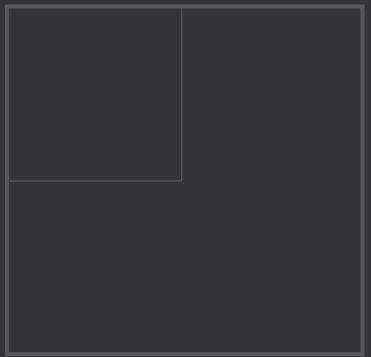
PRINCIPLES OF RESIDENTIAL SPACE CONFIGURATION

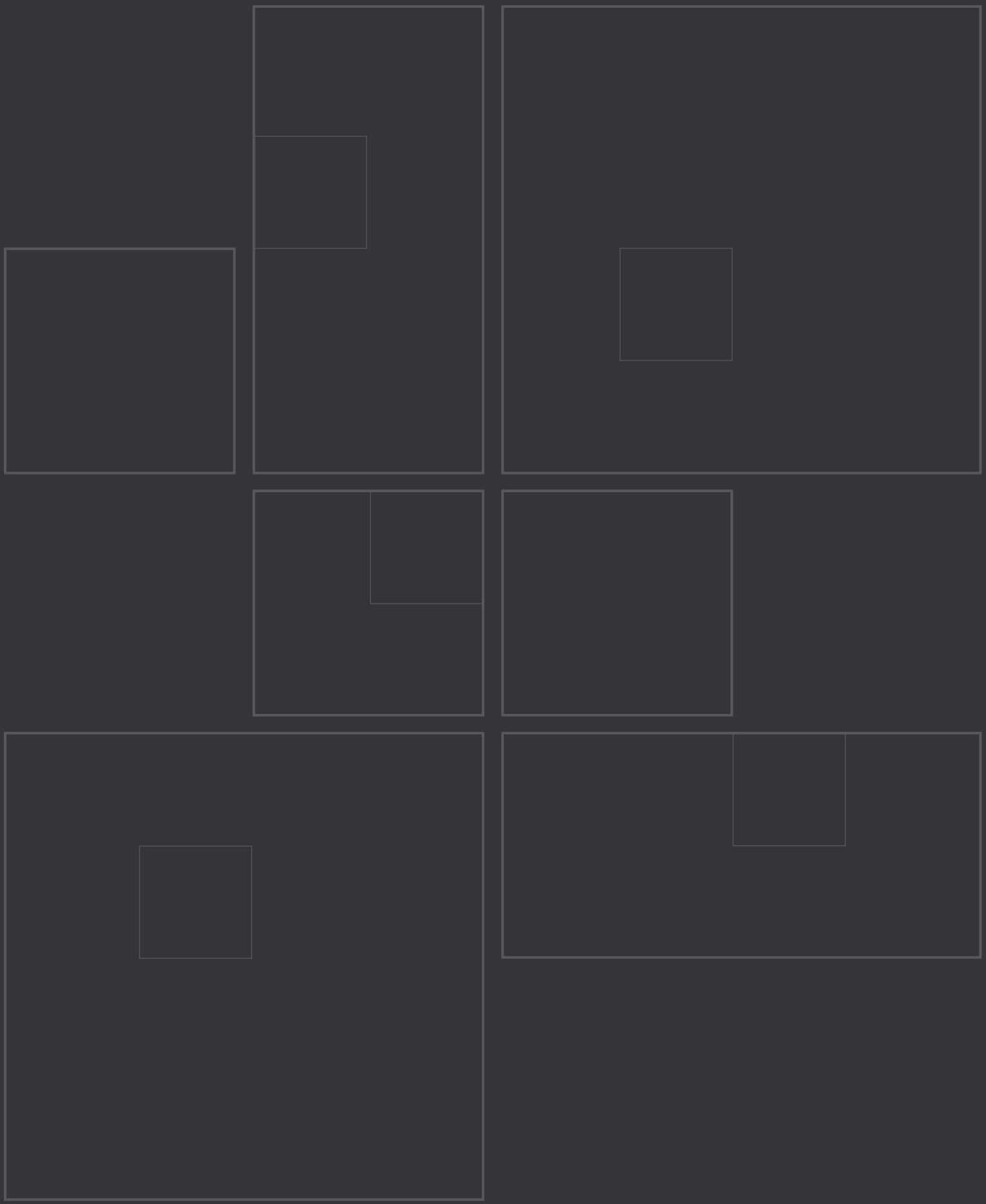
Đorđe Alfirević & Sanja Simonović Alfirević





This book is dedicated to Andrija and Miona,
with the hope that one day they will discover
their true passion and surpass their parents.

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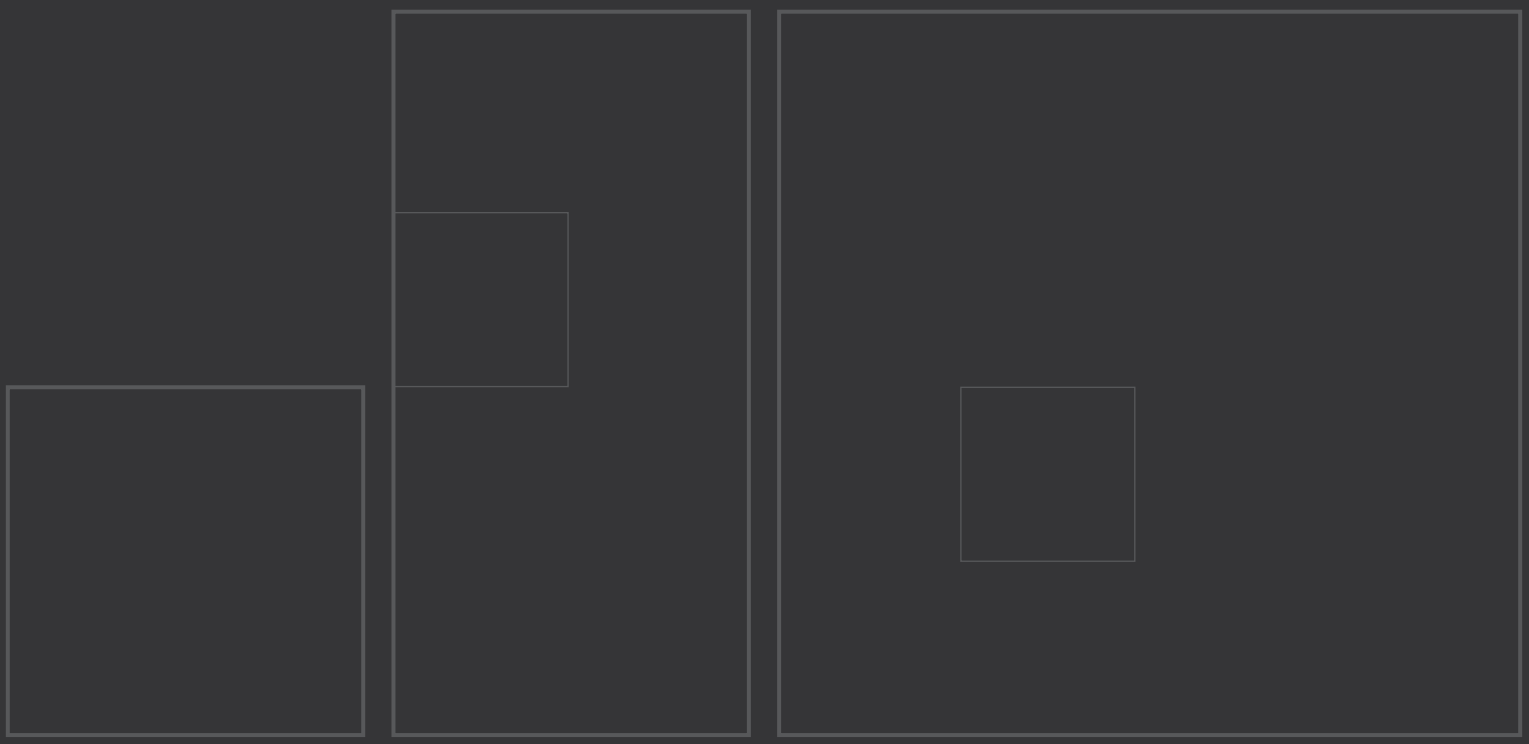

Reviews

Academician Arch. **Branislav Mitrović**,
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Housing is one of the most important architectural themes that has retained its spatial idea throughout history. However, contemporary shifts in lifestyle and everyday philosophy demand a proactive reassessment of established design paradigms. By delving into the nuanced complexities of spatial-programmatic, technological-environmental, socio-cultural, and formal-stylistic perspectives within the typological analysis of residential architecture, the authors of the publication deftly underscore the imperative for a comprehensive and meticulous systematization of its modern values. The distinctive contribution of the research outlined in the book "Principles of Residential Space Configuration" lies in bridging the functional criteria of contemporary housing, stemming from the modern architectural movement, with organizational, structural, and perceptual methodologies essential in shaping the immediate living environment for individuals and communities.

Dr. Đorđe Alfirević and Dr. Sanja Simonović Alfirević's study holds particular significance as a continuum in research endeavors within this domain, building upon the foundational principles of the Belgrade School of Housing. This revitalization of spatial concepts like "circular connections, technical block, human needs, and open plan" underscores their enduring relevance and evolutionary adaptability in modern architectural discourse."

The monograph is structured into six distinct sections: Introduction, Functional Principles, Structural Principles, Organizational Principles, Perceptual Principles, and Conclusion. The introductory section initiates with a comparative analysis aimed at defining the thematic framework of the research. Its primary objective is to theoretically elucidate the concept of spatial configuration and its interrelation with the notions of structure and organization within spatial design. The authors meticulously delineate the terminological nuances between structure and organization, drawing upon their original definitions in system theory and extending these definitions to encompass functional and programmatic implications in design analysis. The fundamental criterion of spatial configuration, rooted in the etymology of the term denoting "shaping," is expounded as a higher-order concept. It entails the deliberate arrangement of components or elements into a defined form, space, or composition, thereby integrating perceptual and aesthetic considerations into the existing systematics. By forging a cohesive link that encapsulates "the structural and organizational aspects of space as integral components," the research narrative achieves a comprehensive synthesis within architectural discourse. This approach fosters methodical rigour and enhances the clarity of pertinent concepts and theoretical viewpoints within the contemporary disciplinary framework.

The second part of the study titled "Functional Principles," delves into interpretations of experiences, perspectives, and practices pertinent to realising the utilitarian aspects of residential space. Underlining that functionality is inherently individual, while quality represents a distinct collective value, the authors pose a pivotal query concerning the interplay between enduring and transient needs, alongside their anticipated future dynamics. The analysis meticulously examines functionalist criteria and standards, incorporating principles rooted in agronomy applications and anthropometric measures. This exploration culminates in a dimensional assessment of functional requirements. Moving forward, the third segment of the study, "Structural Principles,"

adopts a principled approach towards exploring the harmonisation of various functions within residential spaces. This encompasses delineations between conflicting and neutral functions, as well as overarching principles governing their interplay. Moreover, it explores the temporal nature of these relationships, facilitating successive variability, dynamic alternation, continuity, and the inherent potential for spatial flexibility. The fourth segment of the study, entitled "Organizational Principles," delves into the expansive realm of spatial intricacies and the distinctive features of structural frameworks, demonstrated through a myriad of illustrative examples. These examples corroborate the assertion that "factors influencing the organization of residential space stem from a multitude of sources, including human needs, the architect's perspective, and the immediate environment." The authors articulate categories encompassing grouping, integration, and differentiation principles, alongside principles governing variation, placement, and versatility. They undertake an in-depth analysis of diverse motivational influences, such as "spatial layering," "varied interior levels," "open-plan concepts," "organic architecture," "interplay between exterior and interior spaces (nesting homes)," and "architectural techniques for delineating internal diversity, ranging from size and form to materiality, colour, texture, lighting levels, and beyond." The analysis is structured to include specialised sections that explore differentiations grounded in cultural paradigms, spanning from the personal to the communal, the intimate to the public, and from external to internal realms. Additionally, it delves into the potential of integrating enclosed and open spaces, exemplified by open-plan designs and versatile configurations. The discussion encompasses focal points, enhanced communication flows, overlapped elements, and accentuated architectural features to illuminate the nuanced dynamics of spatial organisation within residential contexts.

The fifth segment, titled "Perceptual Principles," delves into the nuanced aspects of spatial perception and the aesthetic reception of the subject matter. Within this section, the authors delineate key principles such as "the principle of configuration" (open plan, circular connection, anfilada, flexibility), the principle of surface dematerialization, illusionism principle, and the principle of framing the vantage point." Through their interpretation, the authors highlight that the concept of spatial pleasantness hinges upon a combination of physical, visual, and tactile parameters of experience. They also underscore the psychological dimensions related to personalization, orientation, and identification within spatial settings, alongside the distinctive character of natural, communal, public, and private architectural forms.

In the concluding discussion, the authors provide an insightful interpretation of the research findings, highlighting the precision, comprehensiveness, and structural clarity achieved in analysing complex figures within a field characterized by deep opacity and scattered foundational frameworks in professional practice. As the authors aptly suggest, this study and its systematization should be viewed more as a proposal than a definitive classification, challenging the field to elevate its intellectual rigour in the absence of a cohesive spatial theory. Drawing from a wealth of previously published research in this domain and employing a rigorous selection, interpretation, and classification of reference materials, the authors make an innovative contribution towards advancing the theory of housing. They delve into concepts such as configuration and subjective experiences, crucial in functional and typological identifications. I firmly believe that this book holds significant value within the realm of architectural and urbanistic scientific literature, warranting careful consideration from the professional community for its original insights into the history and theory of design-urbanistic practices. Given these compelling reasons, I highly recommend the manuscript authored by Dr. Đorđe Alfirević and Dr. Sanja Simonović Alfirević for publication at the Institute of Architecture and Urban & Spatial Planning of Serbia, acknowledging its potential to enrich scholarly discourse in the field.

Belgrade, February 2023

Vladimir Lojanica, Full Professor,
Dean of the University of Belgrade -
Faculty of Architecture

The exploration of organizing residential spaces stands as an extensively studied subject, representing a significant legacy within the architectural profession. This is particularly notable given that the realm of housing extends beyond its immediate concerns to encompass broader social and historical contexts. Delving into housing as a specific design domain necessitates not only reevaluating architectural principles but also engaging with a multitude of related disciplines to establish meaningful cause-and-effect relationships among them. Residential spaces, as tangible environments, are intricately layered and imbued with specific socio-cultural significance, embodying diverse social meanings ranging from fundamental quality standards for dignified living to platforms for societal egalitarianism or stratification.

The publication under review exemplifies a dedicated effort, underscored by the meticulous work of committed authors, to analytically unravel such a multifaceted topic deeply rooted in both practical design and theoretical discourse. It approaches the subject matter with utmost care and responsibility, offering a critical examination of the entire spectrum, from terminological nuances to the diverse array of sources employed.

The monograph "Principles of Residential Space Configuration" directly builds upon historically significant themes initiated by pioneers in the realm of housing within our context, such as Mate Bajlon, Branko Aleksić, Branislav Milenković, Mihailo Čanak, Milan Lojanica, Darko Marušić, and others. In continuing this legacy, rooted in the achievements of the "Belgrade School of Housing," it is enriched and expanded with contemporary examples, new principles, insightful observations, and thought-provoking conclusions. The book's subject matter holds particular relevance in our contemporary post-transitional era, where traditional values in housing are either selectively embraced or entirely discarded in the practical market landscape, often without rigorous critical analysis. Therefore, this publication can serve as a foundational resource for new methodological inquiries, which are highly warranted within the housing domain. Despite our possession of an exceptional tradition and the inherent authenticity of the aforementioned "Belgrade School of Housing," there remains a notable gap in comprehensive social and institutional support for housing research. Such support tends to be inadequate, relying heavily on sporadic, individual efforts from dedicated enthusiasts striving to navigate, comprehend, and transcend the prevalent discontinuity in understanding residential architectural methodologies. Despite being a fundamental yet intricate design subject, literature addressing housing (even in its broadest overview) remains notably scarce, especially concerning theoretical or methodological perspectives.

The content within the book serves as a harmonious blend of theoretical discourse and historical exploration, centering on the origins of terminology and in-depth elucidation of pivotal concepts. The term "spatial configuration," elevated by the authors as a superior concept, serves as the cornerstone for comprehending the intricacies of this subject concerning other relevant terms like structure and organization. A significant theoretical contribution of this work lies in its definition of "spatial configuration in architecture," encapsulating, as articulated by the authors, the application of functional, structural, organizational, and perceptual principles to achieve a holistic aesthetic refinement.

The publication "Principles of Residential Space Configuration," authored by Dr. Đorđe Alfirević and Dr. Sanja Simonović Alfirević, stands as a notable addition to this field, indirectly showcasing the culmination of the authors' ongoing research endeavors throughout their scholarly and professional trajectories. The book unfolds across six well-structured chapters, each dedicated to specific thematic domains. The introductory chapter lays down the theoretical groundwork and establishes key definitions, while subsequent chapters delve into the analysis of functional, structural, organizational, and perceptual principles. Conclusively, the final chapter provides a critical assessment, contemplating the potential trajectories for the evolution of residential space configuration based on the principles elucidated throughout the text.

The structure of the monograph is clearly and logically organized, while the text itself maintains a critical and polemical tone, referencing significant authorities in architecture, sociology, and social theory, thereby encompassing a broad context of critical thought on a global scale. The conclusions drawn are substantiated with examples spanning a wide historical spectrum, lending depth and richness to the book's insights. Visually, the book is replete with illustrations, diagrams, and analytical content. Examples are thoughtfully grouped in alignment with the monograph's chapters, presented through the authors' own illustrations and diagrams, thus enhancing the theoretical underpinnings and fostering a critical synthesis of the subject matter.

The core section of the publication delves into hierarchically structured design principles relevant to residential architecture. These principles are systematically categorized, their interrelationships dissected, and their practical applications demonstrated. Such an approach enables readers to engage with specific thematic elements beyond linear progression, making this work a valuable compendium and pragmatic resource in the realm of residential architecture.

The publication concludes with a chapter urging further advancements in objectively assessing the functional aspects of residential spaces and the paradigms guiding our lifestyle choices. The authors meticulously trace significant historical milestones in residential architecture, duly acknowledging the contributions of predecessors, thus presenting a nuanced, scholarly, and exhaustive historical analysis. They adeptly integrate their own research findings into this analysis, contributing meaningfully to the ongoing discourse in the field.

Viewed as educational material primarily intended for students and pupils of technical high schools, this monograph can be aptly described as a meticulously structured compilation of topics, authors, and examples pertaining to realized and experimental residential projects, organized chronologically. The manuscript is meticulously crafted, demanding full attention from its readers, and consistently presents viewpoints through systems of inductive and deductive reasoning. This approach not only caters to students but also extends its relevance to researchers, architects, and experts from diverse fields associated with architecture. The language employed is communicative and precise, effectively conveying messages while occasionally embracing poetic liberties, thereby enhancing the reading experience with a dynamic flair. Such literature, grounded in theory yet pragmatic in its approach, is indispensable in our contemporary milieu. The monograph stands as a substantial theoretical and research contribution, not only enriching the field of research but also advocating for its prominence within architectural education, which is of vital importance.

The publication at hand is a representative monograph that comprehensively explores contemporary residential issues, thereby making a significant impact on research within our context. Its topical relevance and adept presentation format have garnered a positive evaluation, meriting strong support for its publication.

Belgrade, February 2023

Dr. Mila Pucar, Principal Research Fellow
Institute of Architecture and Urban &
Spatial Planning of Serbia

The monograph titled "Principles of Residential Space Organization" is divided into six chapters. Alongside the Introduction and Conclusion, these chapters delve into thematic units addressing functional, structural, organizational, and perceptual principles that collectively define the configuration of residential space.

In the Preface, the authors explain the motivations behind their exploration of housing topics, specifically focusing on the organization of residential space. They posit that this area remains inadequately researched and lacks thorough theoretical elaboration, failing to keep pace with practical developments. The authors attribute this gap to the prevalent focus among architects on designing, often overlooking theoretical and research endeavors. Thus, this book emerges as an effort to integrate their experiences alongside those of various authors in the design and theoretical realms.

The Introduction serves to underscore the significance of studying principles related to residential space configuration. By analyzing diverse interpretations of this term, the authors highlight the ambiguity often associated with its theoretical application. Consequently, they embark on defining and interpreting this term within the architectural domain, drawing connections between structure, organization, and configuration in the introductory section.

In the second chapter, titled Functional Principles, the authors focus on elucidating concepts that pertain to the essence, articulation, and attributes of specific functions within spatial contexts. They initially underscore the term "human needs" as pivotal in delineating motivations that prompt individuals to engage in various life activities. The fulfillment of these human needs lays the groundwork for the functional arrangement of residential spaces. Within this chapter, the notion of utility value is explored as a fundamental functional principle, dictating that spaces must be appropriately sized, illuminated, and outfitted to align with the execution of specific residential functions. Utility value stands as a cornerstone in architectural discussions surrounding functionality. However, the authors of this monograph contend that the criteria for attaining an elevated utility value in residential spaces remain inadequately investigated. They identify one of the primary causes for this gap as the conflation of utility value with apartment quality. To clarify these concepts, the authors offer a comparative table delineating the distinctions and intersections between utility value and quality, enhancing readers' comprehension. A particularly well-elaborated section within this chapter delves into ergonomics and human-centric design, accompanied by illustrative diagrams and pertinent quotations from various experts. These elements contribute significantly to the explication and examination of these crucial concepts, enriching the discourse on functional principles in residential architecture.

The third chapter delves into “structural principles”, focusing on the examination of compatibility, interconnection, and temporal dynamics of functions within residential spaces. The authors underscore compatibility as the paramount structural principle, delineating it as the system of potential relationships among residential functions dictated by their levels of aggressiveness, neutrality, or sensitivity. A noteworthy aspect of this section in the monograph is the authors' reliance on extensive research, particularly drawing from the works of esteemed theoretician, researcher, and designer Mihailo Čanak. They not only build upon Chank's foundational contributions but also enhance and expand upon them through textual elucidation, illustrative tables, insightful graphs, and detailed drawings. This comprehensive approach enriches the discourse on structural principles, providing readers with a deeper understanding of the intricate dynamics governing functional interactions within residential environments.

The fourth chapter, pivotal within this monograph, delves into “organizational principles” across several segments including grouping, differentiation, positioning, polyvalence, and integration of functions, alongside highlighting key elements within these frameworks. The predominant focus lies on principles influencing the grouping, differentiation, and integration of

residential functions, as they significantly shape the internal spatial structure. In contrast, principles affecting function positioning and polyvalence within residential spaces are less frequently applied. Drawing on a wide array of examples from both domestic and international practices, the authors meticulously research and systematize characteristic functional units and their grouping concepts commonly encountered in residential architecture. This exploration stems from diverse interactions among residential functions, shedding light on the nuanced relationships governing space organization. The authors bolster their analysis by referencing works from various disciplines such as socio-economic, anthropological, and ergonomic research, elucidating the intricate interplay between family dynamics and apartment organization. They address the nuances of differentiating residential spaces to meet specific human needs or to manage potential functional conflicts arising from incompatible functions. Of particular interest is the authors' exploration of specific user group needs, such as children or members of the "third generation," showcasing an innovative approach. Through illustrative examples drawn from practice, terms like "circular connection," "open plan," "salon apartment," "space within space," and "space flexibility" are meticulously defined, enhancing the reader's comprehension of these concepts within the context of residential design.

Chapter five examines "perceptual principles" concerning the experiences of spatiality, spatial comfort, and territoriality within residential spaces. The concept of spatiality is intertwined with visual and spatial comfort, prompting the authors to propose diverse methodologies to enhance these aspects. These methods range from shaping physical space boundaries through strategies like open plans, flexibility, enfilade, or circular connections, to manipulating spatial perceptions via partial, directed, or complete openings towards the environment. The application of optical illusions is also explored as a means to redefine perceptions of spatial boundaries. The notion of "spatial comfort" is scrutinized in contrast to differing perspectives from other scholars, who argue that it arises from well-organized functional spaces and ergonomic environmental design. However, the authors present a nuanced argument in this section, asserting that despite its widespread practical application, a precise scientific definition of spatial comfort remains elusive. They highlight that the parameters for achieving spatial comfort are largely relative and more intricate to analyze compared to parameters for thermal or acoustic comfort. Furthermore, the scarcity of scientific literature dedicated to spatial comfort suggests that this field is still in its nascent stages of development. Overall, this chapter navigates the complexities of perceptual experiences within residential spaces, offering insights into strategies for enhancing spatial comfort and redefining spatial boundaries to foster a more comfortable and engaging living environment.

The Conclusion presents intriguing propositions that open avenues for future research, such as empirical studies aimed at defining parameters that contribute to the "index of polyvalence," further typological explorations and characterization of polyvalent apartments, empirical testing and categorization of territorial boundaries across different human activities, and investigations that could lay the groundwork for standardizing principles and their potential incorporation into regulations. Regarding practical application, the authors suggest that the structural principles and parameters discussed could serve as a foundation for formulating design tasks in collaboration with end-users, tailoring residential spaces to meet specific hierarchies of needs. Further research in this domain could also focus on uncovering and analyzing additional principles not covered in this book, such as the readability or expressiveness of residential spaces, typologies related to enfilades and circular connections, experiences of territoriality within communal living concepts, and their systematic integration into the proposed or new relational frameworks. This ongoing exploration and refinement of principles could significantly contribute to advancing the field and enhancing the quality and adaptability of residential environments to better align with diverse user needs and preferences.

The manuscript continues with an extensive bibliography, which proves invaluable for researchers intending to delve into this highly significant topic in the future. Throughout the text, footnotes are used to reference the authors' perspectives as well as engage with the

viewpoints of various cited researchers, accompanied by carefully chosen examples from real-world practice. The manuscript includes a substantial number of bibliographic references, including self-citations, falling under categories M20 and M50. This comprehensive approach not only contributes significantly to the field of study but also aligns with the criteria for a monographic work.

Considering the thoroughness and scholarly depth exhibited in this manuscript, I am pleased to recommend the acceptance and publication of "Principles of Residential Space Organization" authored by Dr. Đorđe Alfirević and Dr. Sanja Simonović Alfirević.

Belgrade, March, 2023

Foreword

Housing, being one of the most intricate subjects in design, has been a focal point for researchers across centuries. Despite the wealth of scientific literature on this subject, books specifically dedicated to residential space organization are relatively scarce from today's perspective. This scarcity can be attributed to the fact that architects primarily express their professional identity through design endeavors, with fewer practitioners engaging in theoretical and research-oriented work. In our pursuit to consolidate experiences, we have embarked on a journey to delve deeper, record, and share insights derived from our projects.

The idea for compiling this book stems from years of immersion in design and research within the realm of residential architecture. The content presented here encapsulates a culmination of theoretical and historiographical explorations that we, as researchers, have delved into, aiming to unravel the core essence of various design concepts pertinent to residential spaces. Many of these principles find application not only in residential architecture but also extend to other architectural domains such as public and sacred structures. Thus, we envisage that the contents of this book will have broader implications and prove beneficial to a diverse readership comprising students, researchers, and designers keen on delving into architectural theory and practice.

The book is structured into several chapters, each exploring thematic units centered on functional, structural, organizational, and perceptual principles that collectively define the essence of residential space configuration. We perceive the term "space configuration" as a comprehensive umbrella term encompassing these fundamental concepts, serving as the cornerstone for grasping the intricate and multifaceted nature of residential architecture. Our intention was not to

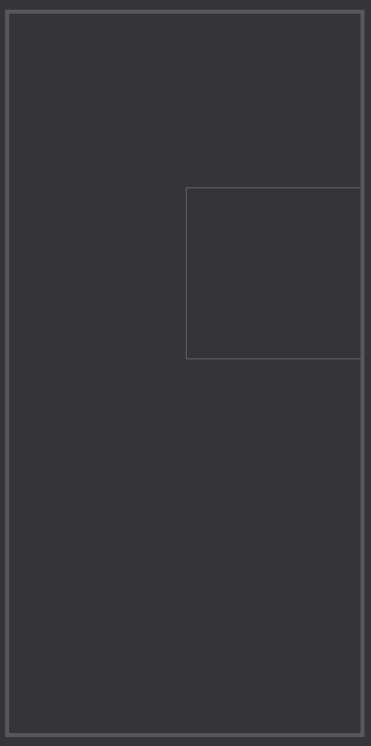
exhaustively cover all design principles within the architectural realm but rather to elucidate their hierarchy, interconnections, and provide a structured overview, focusing on those that are quintessential and commonly applied.

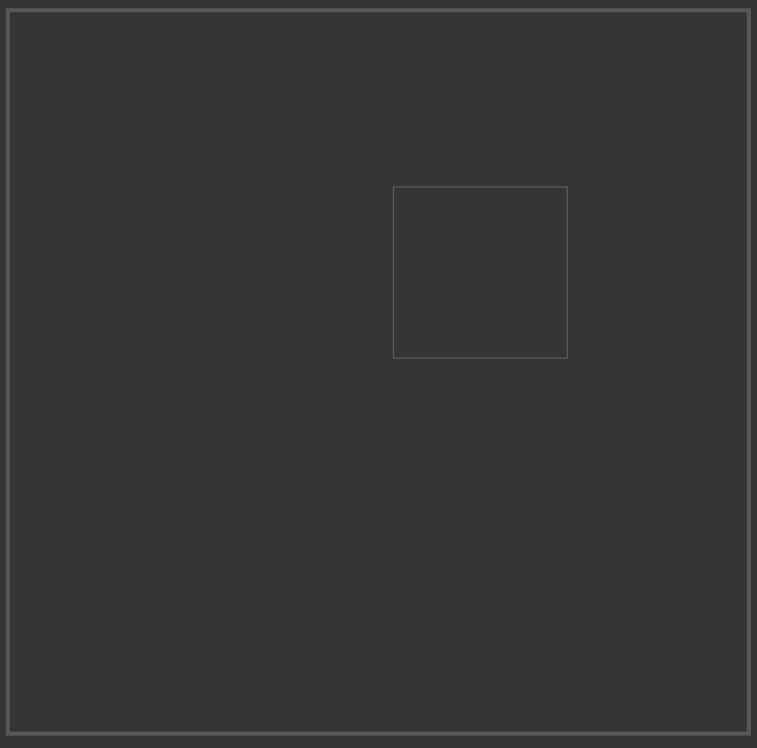
Readers can approach the book sequentially, following the proposed order, or focus on specific thematic units of interest. The thematic framework of this monograph has been significantly influenced by our enduring association with the eminent Serbian architect and scholar of residential architecture, Dr. Mihailo Čanak (1932–2014). Our conversations with him over the years sparked our interest for various residential architecture design principles, leading us to explore and research topics of significance. Circular connection, technical block, human needs, open plan, and other topics presented in the book colored our conversations and focused our attention on the field of housing. While Dr. Čanak played a pivotal role, our academic journey has also been shaped by the guidance of our professors, senior colleagues, and the exploration of the Belgrade School of Housing and its impact on Serbian architectural discourse. Publications and scholarly works by our mentors and esteemed colleagues have further enriched our understanding and directed our focus towards research in residential architecture.

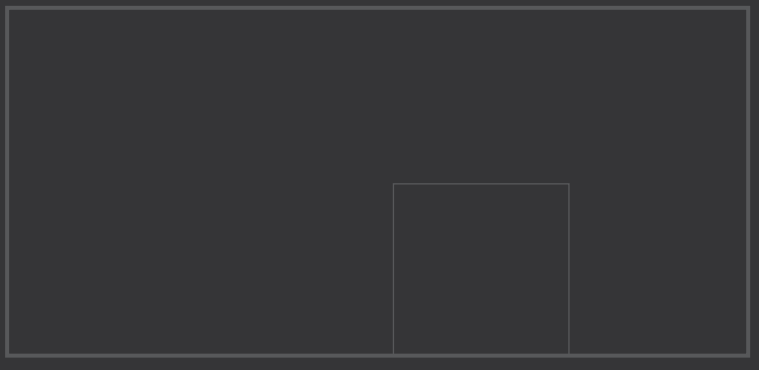
Through this publication, we aspire to broaden readers' comprehension of residential architecture and inspire further exploration in this domain. For us, housing is the foundation for contemplating architecture, a perspective we aim to share with fellow researchers and architecture enthusiasts alike.

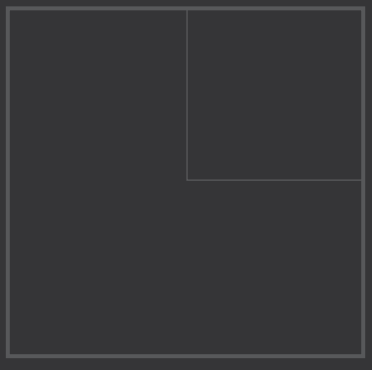
Belgrade, 2023

Authors






I INTRODUCTION

The focus of this monograph lies in exploring the intricacies of residential space configuration. The term "configuration" is frequently used in architectural discourse, often assumed to be self-explanatory despite lacking a precise definition. Even a superficial examination of its varied interpretations reveals that its application remains ambiguous. The introductory section will delve into these interpretations, particularly in relation to the terms "structure," "organization," and "configuration" within architecture. Through a comparative analysis of these concepts, the interrelationships will be clarified, leading to a precise delineation of "space configuration." The monograph is structured into several chapters, each exploring the principles[1] that underpin space configuration. The primary research objectives include:

1) Theoretical clarification of "space configuration" and its interplay with "structure" and "organization" in spatial design;
2) Systematic exploration of key design principles essential for achieving residential space configuration;
3) Reassessment of the notion that configuring residential space involves a multifaceted process encompassing functional, structural, organizational, and perceptual spatial considerations.

1 The principle (Latin: *principium* - principle, rule, doctrine) represents a fundamental stance or guiding idea that individuals use to navigate decision-making processes.

1.1. Structure

Structure (Latin: *struere* - to build) encapsulates the organization and interplay of elements within a material entity or system. These elements encompass various conceptual, tangible, or abstract components that collectively form a system. Each element can on its own represent a system, functioning as a subsystem within a larger framework. The interconnectedness and relationships among these elements define the structure of the system. As Čedomir Čupić suggests, structure emerges when elements are intricately linked to form a cohesive entity with distinct characteristics, and where the properties of these elements are influenced, wholly or partially, by the properties of the whole.[2] It's crucial to note that mere aggregation of elements into a whole, lacking clear relational concepts, does not constitute structure; it remains a composition devoid of structural integrity. (Figure 1)

Composition encompasses the fundamental building blocks or components of a whole, while the arrangement and interconnection of these elements, along with the elements themselves, give rise to structure. It is crucial to highlight that the structure of a system undergoes transformation with changes in the relationships between its parts, even if the composition and positions of elements within the system remain unaltered. (Figure 2) The above assertion underscores that variations in the arrangement and interconnection, that is, the relationships among elements, lead to distinct structural formations. Any significant alteration in a relationship or element triggers corresponding changes in other elements and relationships within the structure, highlighting the interconnected nature of these components.

2 Čupić, *Sociologija: struktura, kultura, vladavina*, 18.

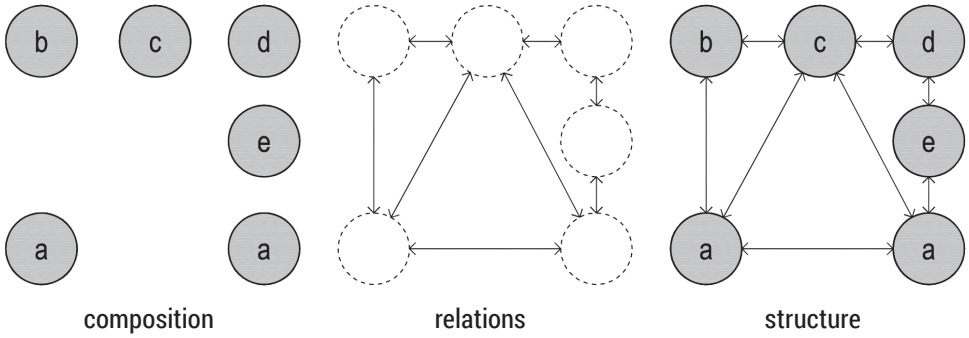


Figure 1 Composition and relationships in the structure (Source: Authors' drawing)

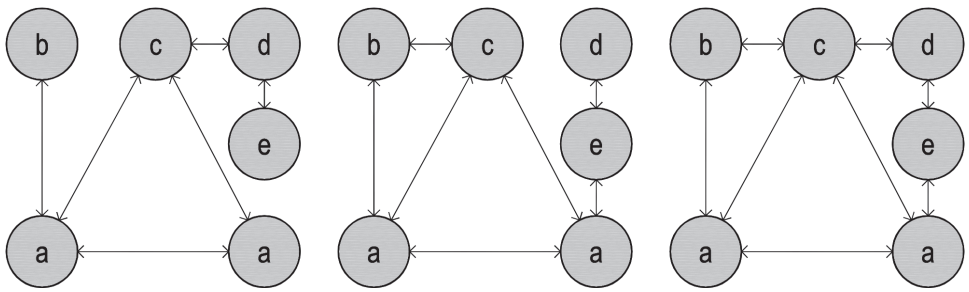


Figure 2 Structures with the same composition and positions of elements, but different relationships between elements (Source: Authors' drawing)

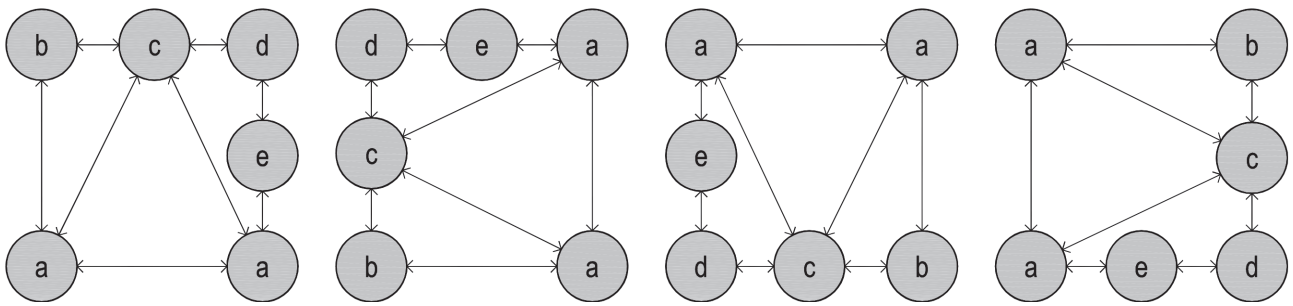


Figure 3 Differences between structures with the same composition and the same relationships between elements (Source: Authors' drawing)

Čupić highlights that when equilibrium within a structure is disrupted, a new equilibrium emerges at a different level, illustrating that the "structure captures a snapshot of a phenomenon at a specific moment in its evolution."[3] This viewpoint suggests a dynamic, variable character of the structure, which is one of its significant features. According to Miško Šuvaković, structure comprises interconnected elements and elements in mutual relation, with their specific and general attributes governed by the overarching principle of the whole or the internal relationships among elements.[4] Vladimir Milić shares a similar viewpoint, stating that the essence of structure lies in its wholeness, divisibility into constituent parts, and the interplay between the whole and its components, as well as among the components themselves.[5]

When referring the structural aspects of residential space, Mihailo Čanak believes that "the system of internal connections between rooms in an apartment represents one of the most important factors of the apartment's structure". In his view, the apartment's structure "manifests through the relations between residential functions, which connect individual actions into a unified process."[6] He also points out a terminology issue, noting that "the term "apartment's structure" usually implies the number and character of rooms in the apartment, while under the "apartment's organization", one understands the system of connections between rooms and their positions within the apartment."[7] Seeking to add clarity to this terminology, Čanak stresses that "the apartment's structure encompasses the intricate web of connections and communications among rooms, alongside the count and purpose of rooms in the apartment."[8] This perspective highlights the author's clear distinction between the composition and the relationships among elements, both integral to defining the structure. Viewing the apartment as a spatial system, with rooms as its constituent elements and the connections between rooms as the links or relationships among these elements, it becomes apparent that "these connections primarily arise based on the intended function of individual rooms, illustrating that the network of connections is inseparable from both the number and purpose of rooms."[9]

1.2. Organization

Organization (Greek: *οργανον* (organon) - instrument, organ) is a term that signifies the coordination of subjects or the grouping of objects based on varying interests, goals, or purposes. This term encompasses both social systems, involving individuals or social groups, and physical or spatial systems, which involve arranging elements (objects or space) into a unified whole based on a superior idea or motive that transcends the mere relationships between constituent elements. From this definition, it becomes apparent that while structure and organization share interconnected meanings, they are not synonymous. When considering similar structures with identical compositions and mutual relationships between elements but differing spatial placements of elements, variations in spatial arrangement become evident. These differences often stem from distinct influencing factors or motives. (Figure 3)

When translating this perspective to the realm of architecture, it indicates that organizing residential space involves the systematic arrangement and connection of rooms towards a coherent whole guided by a higher objective or what is often termed a "constitutive motive". The initial definition of the term constitutive motive in residential architecture originates from the theoretical framework of architect Darko Marušić. According to Marušić, the "constitutive motive serves as a unifying

3 Čupić, *Sociologija: struktura, kultura, vladavina*, 14.

4 Šuvaković, *Pojmovnik suvremene umjetnosti*, 592.

5 Milić, „Struktura," 594.

6 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*, 171.

7 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*, 304.

8 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*, 25.

9 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*, 24.

element and the essence of spatial organization in architecture. It carries a spiritual connotation, representing a centralizing force, a conceptual message, or guiding principle pivotal to the design concept. In material terms, it can manifest as an element, surface, or space."[10] The decision to choose constitutive motives in designing is largely influenced by the subjective perspective of the designer, along with various contextual considerations.

In discussing the organization of residential space, Čanak states that "organization embodies a dynamic and self-regulating structure, harmoniously interacting with its surroundings, actively pursuing the system's objectives. Within the 'dwelling-user' system, this manifests as the coordinated interaction among the dwelling, user, and environment to fulfill a specific array of human needs, essentially representing the process of habitation."[11] Therefore, key factors influencing concepts of spatial organization encompass: 1) physical structure, 2) human needs (user), 3) environment, and 4) creative vision (architecture).

1.3. Configuration

The term configuration is derived from the Latin word *configuratio*, which means "shaping." It holds significance across diverse domains of human endeavor including arts, engineering, psychology, geography, and architecture, among others. Depending on the specific context of its application, it often intersects with the term "structure," particularly concerning the composition or arrangement of elements within a system (be it software, hardware, or composition). However, a key challenge with these interpretations often arises from the oversight of its fundamental meaning and its intrinsic connection to the formal attributes of the system.

When applied within the realm of architecture, the term "spatial configuration" primarily signifies the organization of parts or elements within a specific form, space, or composition.[12] This perspective aligns closely with the concept of "structure," as described by Jean Piaget, where elements within a system adhere to laws that define the system itself.[13] This viewpoint is echoed by Jong Ook Kim, who defines configuration as "a spatial pattern that delineates the interrelation of all spatial elements."[14] Faris Ali Mzoori contributes to this discussion by characterizing spatial configuration as the arrangement of space elements in a tangible and defined manner within a specific form, fostering distinct relationships between interior and exterior spaces,[15] as well as between different aspects of space.[16] From Mzoori's perspectives, significant aspects of interpretation can be recognized - spatial arrangement and spatial relationships. John Peponis expands this understanding by highlighting that spatial configuration also encompasses the potential movement patterns within defined spatial boundaries, as well as the connections and interruptions arising from the presence of these boundaries.[17] Esin Hasgül adds another dimension by defining spatial configuration as a dynamic process that intertwines the built environment with human spatial experiences and behaviors.[18] From these various perspectives, it becomes evident that spatial configuration involves more than just arranging

10 Marušić, *Projektovanje 2: Višeporodično stanovanje – Sveska 4*, 3.

11 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*, 37.

12 Hillier, *Space is the Machine: A Configurational Theory of Architecture*; Hillier and Hanson. *The Social Logic of Space*.

13 Pjaže, *Strukturalizam*.

14 Kim, *Spatial Configuration, Spatial Cognition and Spatial Behaviour: The Role of Architectural Intelligibility in Shaping Spatial Experience*, 54.

15 Mzoori, *Spatial Configuration and Functional Efficiency of House Layouts*, 35.

16 Mzoori, *Spatial Configuration and Functional Efficiency of House Layouts*, 44.

17 Peponis, "Geometries of Architectural Description: Shape and Spatial Configuration," 34.1.

18 Hasgül, "Space as Configuration: Patterns of Space," 1.

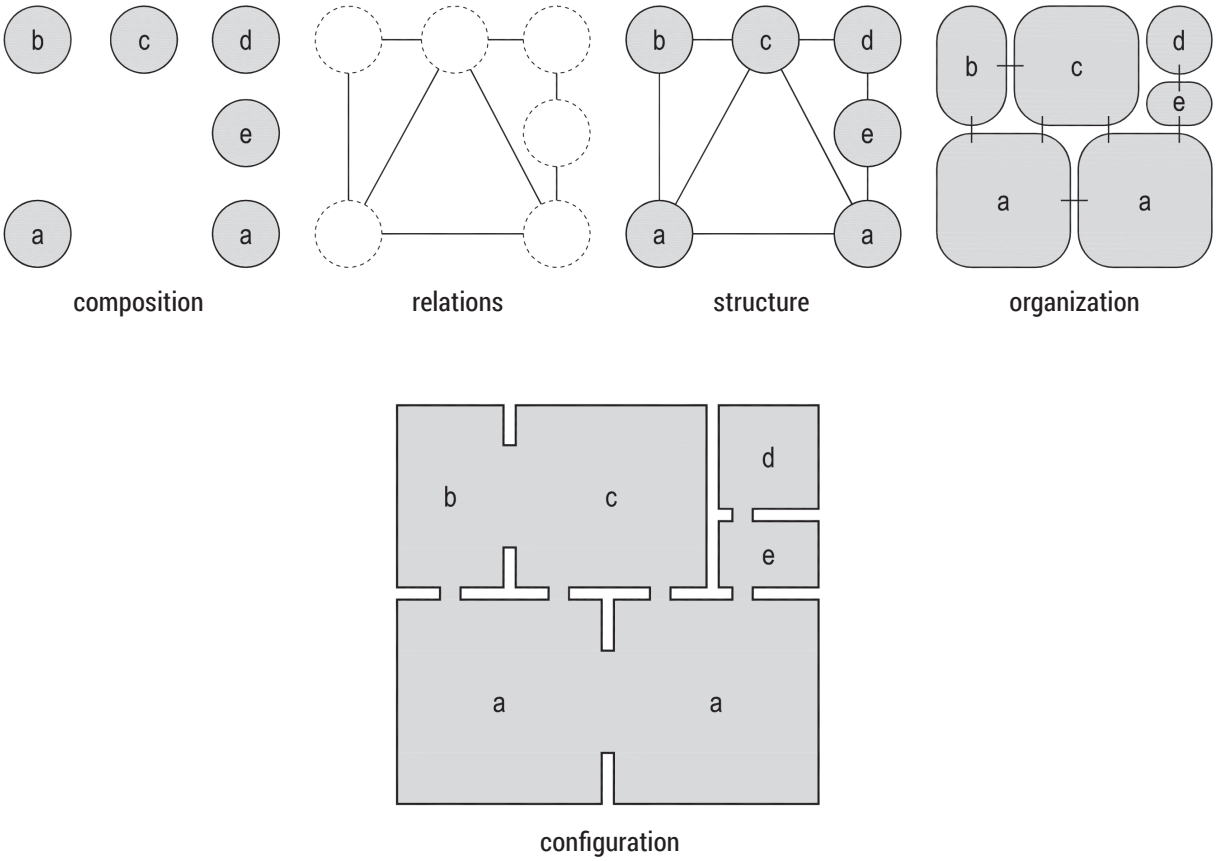
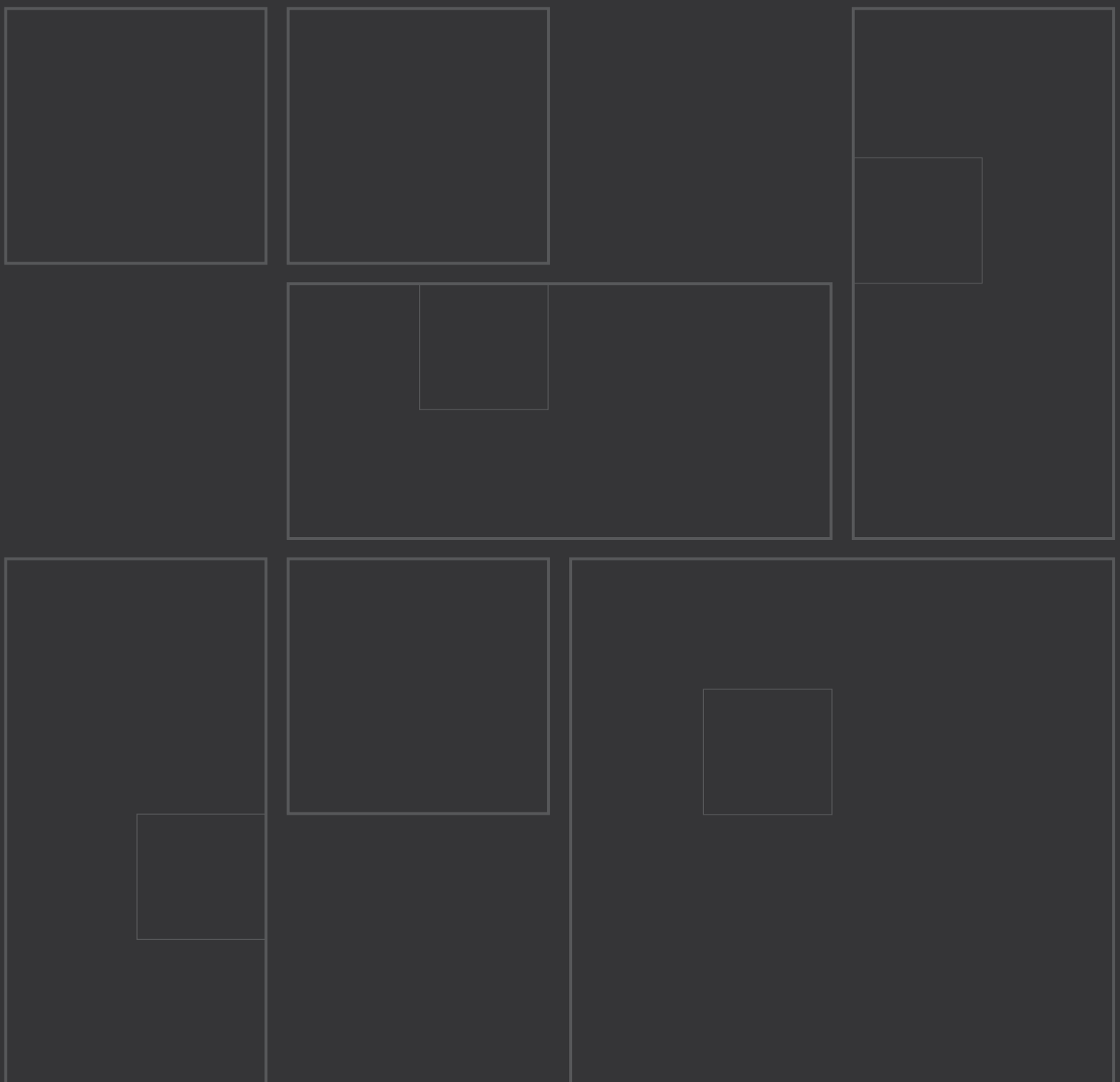


Figure 4 Criteriaaffectingtheconfigurationofspace(Source: Authors' drawing)

elements; it encapsulates the holistic experience of space and the activities undertaken within it, thereby bridging the gap between physical form and human engagement with space.

From the presented interpretations, it is evident that the term "spatial configuration" encompasses not only structural aspects such as the composition and relationships of elements but also organizational aspects like arrangement and pattern. Therefore, configuration can be seen as a comprehensive term that integrates both the structure and organization of space, which are fundamental components of it. It is important to emphasize that configurations also encompass individual perceptual and aesthetic aspects related to the experience of space. This indicates the existence of a distinct domain of meaning that is not fully encapsulated by the terms structure and organization but is nevertheless integral to configuration. Given the above, we will establish a working definition of the term "spatial configuration" to clarify the causal relationships among these concepts (Figure 4):

In architecture, spatial configuration refers to the application of functional, structural, organizational, and perceptual principles aimed at achieving its comprehensive aesthetic shaping.



II FUNCTIONAL PRINCIPLES

„A house is a machine for living." (Le Corbusier)

Functional principles in architecture encompass perspectives or determinations concerning the composition, presence, and characteristics of specific functions within a space. These principles are instrumental in ensuring that certain human needs are met through the facilitation of various activities within appropriately designed spaces. For example, spaces such as living rooms or reception areas are essential for fostering family gatherings and social interactions, while areas like kitchens, pantries, and similar spaces are necessary for food storage and preparation.

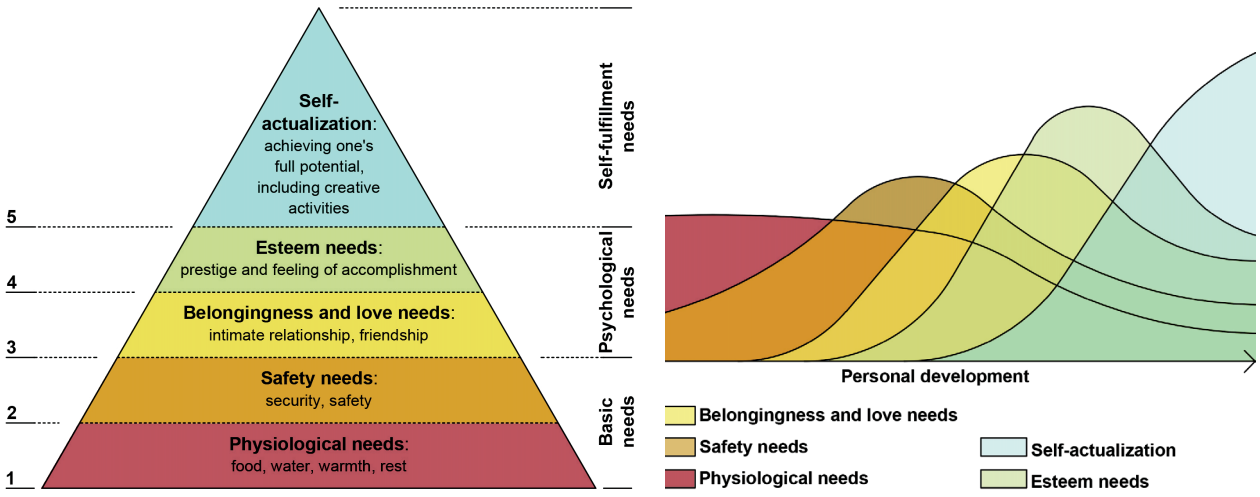
The term "human needs" refers to the motivations that drive individuals to engage in various life activities. Broadly speaking, human actions can be viewed as endeavors to fulfill specific needs.[19] The concept of organizing human needs and understanding their interconnections was initially developed by the American psychologist Abraham Maslow in his seminal work "Theory of Human Motivation."[20] In this work, Maslow posited that human needs can be categorized into groups and that there exists a hierarchical structure among these needs. According to his theory, lower-level needs must be addressed before higher-level needs can be activated. Maslow classified human needs into five hierarchical levels, starting from the most fundamental physiological needs, followed by safety needs, needs for belongingness, needs for esteem, and finally, needs for self-actualization.[21]

19 Guillen Royo, "Human Needs."

20 Maslow, "A Theory of Human Motivation."

21 Physiological needs (need for air, water, food, sleep, and sex); needs for safety (physical safety, material and health security (employment and health), family and property security); needs for belongingness (friendship and family ties); needs for esteem (self-respect, success, respect for others, recognition of one's achievements); and needs for self-actualization (creativity, morality, spontaneity, problem-solving, lack of prejudice, acceptance of facts).

Figure 5 Hierarchy of human needs according to A. Maslov (Source: Authors' drawing)



Maslow's hierarchy is typically depicted as a pyramid divided into five segments, each corresponding to a specific level of human needs. The prevailing belief is that higher-level needs within this hierarchy become prominent only after lower-level needs are adequately met. Moreover, as one need is fulfilled over time, its importance diminishes, making way for the emergence of other needs and their subsequent interplay. (Figure 5) Maslow's motivational theory remains highly influential in the field of human needs research.

While the fulfillment of human needs serves as the foundation for the functional organization of residential spaces, it is crucial to note that residential environments cannot address all these needs comprehensively. Instead, some needs necessitate interactions and activities beyond residential confines, involving other individuals, places, or objects. Conversely, architects play a pivotal role in discerning which needs are enduring and which are transient for users, as well as identifying evolving trends in temporary needs transformation.[22]

2.1. Efficiency

The concept of space functionality has been a topic of discussion in architecture since the time of Vitruvius (Marcus Pollio Vitruvius), who emphasized in the 1st century BC that architecture is rooted in the harmony and balance of three core principles: beauty (*venustas*), firmness (*firmitas*), and utility (*utilitas*).[23]

Utility represents a fundamental functional principle, dictating that space must be appropriately dimensioned, illuminated, and structured to accommodate specific residential functions. Each part of a residential space, especially individual rooms, must be purposefully designed to serve a specific function or fulfill a particular human need. It is only when every part of the residential space aligns with its intended purpose that it can be considered utilitarian, possessing a certain utility value.

Utility value is a fundamental concept in architectural discussions about functionality. It refers to the degree of usefulness of a specific space for its users, indicating how well the space can fulfill specific human needs.[24] It encompasses a spectrum of usability, with a minimum threshold below which typical space utilization cannot be considered.

The concept of the *flat's use value*[25] was introduced into the scientific discourse in the 1970s by a group of professors from the Faculty of Architecture in Belgrade, including Mate Bajlon, Branko Aleksić, and Branislav Milenković). Their focus was on exploring the principles of spatial and functional organization within residential spaces to optimize the organization of high-quality apartments within limited areas. They introduced the term 'flat's use value' to encompass the criteria they believed could enhance the quality of an apartment during its usage phase. Since then, several decades have passed, yet the application of the term remains relevant. However, despite considerable academic discussion on

22 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

23 The term "utilitas" is translated differently by various authors, such as usefulness, utility, utilitarianism, and so on. Vitruvius defines it as a condition where "the arrangement of space has no defect or hindrance for use." (Vitruvije, *Deset knjiga o arhitekturi*, 18).

24 Alfirević i Simonović Alfirević, "Achieving Use Value of a Living Space."

25 The term "use value" has been well-established in theory for quite some time. It is widely acknowledged that Karl Marx provided a more precise definition of it in his work "Capital" (1867), where he asserts that "the usefulness of a particular thing renders it a use value." (Marks, *Kapital*, 44).

the subject[26], the criteria for achieving a higher level of use value in residential space are still insufficiently explored. One of the primary reasons for this situation is presumed to be the conflation of the term 'use value' with the quality of the apartment.

In his book "Housing: Topic 1 – Organization of the Apartment," Mate Bajlon emphasizes that an apartment's use value should be evaluated based on the specific needs, the number of occupants, and the family or group structure it accommodates.[27] He argues that the utility of an apartment is primarily determined by human needs and the number of residents it can house. Furthermore, Bajlon points out that two apartments of identical size can possess varying use values, just as the same apartment can serve different purposes for one or more individuals. While Bajlon introduces the concept of use value, he does not extensively elaborate on its interpretation in his works but rather adopts and applies it without detailed prior explanation. Even in his publication titled "Use Value of the Apartment," the focus remains primarily on analyzing design principles that contribute to enhancing an apartment's use value, without delving into the theoretical significance of the term itself. Bajlon outlines several criteria crucial for assessing and enhancing an apartment's use value, including aspects such as 1) separating children by gender, 2) separating children and parents, 3) separating personal living spaces and shared living spaces, 4) bringing the family together around a family table, 5) the possibility of forming a circular connection, 6) the possibility of forming extended circulation area, 7) uninterrupted reception of guests, 8) flexibility, 9) a passage through the living room, 10) a working kitchen, 11) storage spaces, and 12) open areas.[28]

Mihailo Čanak made a significant contribution to this field through his research,[29] which dealt with the relationships between the use value of apartments and flexible residential structures, functional apartment concepts, and methods of assessing the use value and quality of apartments. A noteworthy aspect of Čanak's work is his study "Functional Concept and Use Value of Apartments," where he delves into the concept of value across various disciplines such as philosophy and economics, offering a comprehensive definition of the term. According to Čanak's definition, "the use value of an apartment is defined by its utility for individuals, families, or society as a whole, reflecting its capacity to positively impact the fulfillment of human needs, desires, and objectives through its attributes."[30] In his attempt to explore the possibilities of assessing the use value of apartments, Čanak analyzes models of valuation applied worldwide. However, his research often shifts focus towards evaluating the quality of apartments rather than exclusively concentrating on their use value. It can only be assumed that this equating of the terms "use value" and "quality" was conditioned by the author's desire to delve further into the objectification of criteria and valuation models.[31]

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26 Bajlon, „Neka pitanja u vezi sa upotrebnom vrednosti stana, stan i stanovanje"; Bajlon, *Upotrebna vrednost stana; Stanovanje: Tema 1 – Organizacija stana;* Čanak, *Fleksibilnost stambenih struktura kao činilac upotrebne vrednosti stana;* Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana;* Čanak, „Formiranje sistema vrednovanja upotrebne vrednosti stana"; Čanak, *Regulativna istraživanja funkcionalnih aspekata i upotrebne vrednosti stanova, zgrada i naselja*; Čanak i Gavrilović, *Funkcionalna koncepcija i upotrebna vrednost stambene zgrade*.

27 Bajlon, *Upotrebna vrednost stana*, 10.

28 Bajlon, *Upotrebna vrednost stana*.

29 Čanak, *Fleksibilnost stambenih struktura kao činilac upotrebne vrednosti stana;* Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana;* Čanak, „Formiranje sistema vrednovanja upotrebne vrednosti stana"; Čanak, *Regulativna istraživanja funkcionalnih aspekata i upotrebne vrednosti stanova, zgrada i naselja*; Čanak i Gavrilović, *Funkcionalna koncepcija i upotrebna vrednost stambene zgrade*.

30 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana, 374.*

31 Čanak, *Vrednovanje kvaliteta u stambenoj izgradnji i stanovanju.*

Value	Use value	Quality
"... implies characteristics that make objects the target of human endeavors". (Panchauser, „Klasifikacija upotrebne vrednosti stanova.")	"... manifests itself in its utility for one or more individuals, a family, or society as a whole, i.e., its ability to positively influence the satisfaction of human needs, desires, and goals through its characteristics". (Čanak, Funkcionalna koncepcija i upotrebna vrednost stana, 374)	"... is the level to which a set of corresponding characteristics meets requirements". (***, „Sistemi menadžmenta kvalitetom: Osnove i rečnik, JUS ISO 9000:2001," 12)
"... is a measure that creates certain orientations in human behavior and actions". (Životić, Aksiologija, 48)	"... is the dimensional-organizational quality of a residential space". (Marković, „Šta je upotrebna vrednost stana, zašto je ona bitna i kako je proceniti?")	"... is the level, in current circumstances, determined by the degree of compliance with standards and professional requirements of all relevant individual characteristics of the dwelling, residential building, and surroundings, classified on a specific value scale." (Todorović, Doprinos standardizaciji kvaliteta organizacije prostora stana u Srbiji na osnovu savremenih principa stambene izgradnje u Holandiji, 116)

Table 1 Comparison of the terms "value", "use value" and "quality"

One of the recent references worth mentioning is the paper by Dragan Marković titled "What is the use value of an apartment, why is it important, and how to evaluate it?", where the author states that the use value of an apartment is "the dimensional-organizational quality of a residential space. As such, it can be determined using numerical and relational parameters".[32]

Upon examining these interpretations, it becomes apparent that equating the terms "use value" and "apartment quality" has led to some confusion. It is therefore important to briefly compare these terms and ascertain whether they represent distinct concepts or if they are essentially equivalent. (Table 1)

In the domain of housing, upon examining the presented views, it becomes evident that "use value" refers to the usefulness of an apartment for the individual using it. This parameter indicates how effectively the residential space enables the user to fulfill their needs during occupancy. On the other hand, "apartment quality" encompasses a range of criteria that define the positive attributes of a residential space, including the level of satisfaction not only of the user's needs but also of broader considerations stemming from the immediate and wider environment (such as construction, materials, positioning within the building structure, within the community, within the city, etc.). Unlike the use value of residential space, which is determined by the specific ways in which users (individuals or groups) utilize it and can vary between individuals, the quality of residential space is evaluated against established standards and generally accepted social norms.

Hence, it can be posited that the use value of residential space is somewhat "personalized" since it hinges on the specific needs of real users, whereas the quality of residential space denotes the extent to which certain features of the apartment align with the general

32 Marković, „Šta je upotrebna vrednost stana, zašto je ona bitna i kako je proceniti?"

expectations set by norms and standards. Consequently, the quality of residential space represents a significantly broader category, encompassing, among other factors, its use value, which remains confined within the space's boundaries.

In terms of the quality and use value of residential space, values serve as measures or benchmarks toward which human endeavors strive. In this context, the concept of the value of residential space emerges as a more overarching category than both its quality and its use value, encapsulating them within its scope. Thus, it can be inferred that the overall value of residential space is determined by three fundamental parameters: 1) use value, 2) quality, and 3) material value (price). Beyond these dimensions, one might also consider the "spiritual value" of residential space, which reflects the personal or emotional significance a space holds for its user.

Based on the above, it can be concluded that use value pertains to the utility of residential space for its occupants. It denotes a spectrum of usability, with a threshold below which standard space utilization cannot be considered. Any enhancement beyond this threshold partially belongs to the range of space quality. Consequently, to ensure that residential space possesses a sufficient level of use value, specific conditions must be met. Meeting these conditions enables the space to cater to the user's needs effectively, thereby embodying utilitarian qualities.

2.1.1. Spatial conditions to satisfy physiological needs

Residential space does not directly cater to physiological needs but provides a spatial framework for their continuous fulfillment. For example, spaces designated for food storage, meal preparation, and dining indirectly impact the satisfaction of the need for food and drink. These areas support daily activities aimed at meeting these basic needs. To ensure smooth functioning in these areas, it is crucial that the spaces are ergonomic, meaning that they are designed and aligned with the dimensions of the human body. The minimum linear dimensions required for basic room functionality are as follows: a single-row kitchen should have a width of 160cm, a double-row kitchen should be at least 210cm wide, and a dining room should measure a minimum of 200cm in width. Meeting the need for excretion requires sanitary spaces with specific minimum widths, such as 80cm for a toilet and 160cm for a bathroom. In residences accommodating three or more individuals, an additional toilet besides the bathroom becomes necessary for regular use. Adequate rest and sleep, under normal circumstances, necessitate a soundproof room capable of accommodating a bed of suitable dimensions. For instance, a room with a double bed must be at least 260cm wide, while a room with two separate beds should be at least 240cm wide. Similarly, a room with a single bed should have a minimum width of 190cm. These dimensions represent critical minimums below which residential functions cannot operate normally, thus impacting the use value of residential space.[33]

Depending on how space is organized, the proportions of a room, and its minimum linear depth and width, one can estimate the necessary minimum areas required for residential functions to operate normally.[34] It is crucial to highlight that a room with an irregular or fragmented shape, even if it has a suitable area, generally fails to meet expected functional requirements. Therefore, it is advisable to aim for rectangular or square proportions in rooms to achieve optimal use value of residential space

33 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*; Čanak, *Svi moji stanovi*.

34 For detailed information regarding spatial dimensioning procedures, including the determination of minimum surface areas, depths, and widths of spaces, you can consult the following resource: Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

While the height of a room does not significantly impact the use value of residential space, it does influence the comfort experience and the required air volume for normal functioning in unventilated conditions. A height of 226cm is considered the lower limit for a room's useful height, below which prolonged occupancy may lead to discomfort and feelings of claustrophobia.[35] The optimal height for a residential space, which directly affects its use value, is typically around 260cm.

2.1.2. Spatial conditions to satisfy safety and comfort needs

One of the fundamental roles of every residential space is to address the needs for security and comfort. Security in residential space involves protection from various external and internal influences, while comfort entails a sense of pleasantness and physical and psychological well-being during occupation.[36]

To cater to the need for physical security, the ergonomic design of space and furniture plays a crucial role. Factors such as absence of sharp edges and corners, irregular or poorly dimensioned objects or areas within the space significantly contribute to this aspect. Meeting security needs in residential spaces involves incorporating mechanisms that safeguard against burglary, such as secure entrance doors, balcony doors, and windows. In certain cases, addressing the need for material security can involve including a dedicated workspace (office, study, studio, etc.) within the residential area, possibly with a separate entrance, allowing users to engage in professional work activities securely. The need for health security and well-being can also be fulfilled within residential spaces by ensuring adequately dimensioned areas for personal hygiene, such as bathrooms and toilets. Additionally, incorporating spaces for relaxation and recreation, such as a fitness room or a gym, further contributes to maintaining overall health and well-being within the residential environment.

The most significant group of parameters comprises those that satisfy the needs for privacy and isolation, which is particularly important in residential spaces with multiple users, whether it is a family or a group of unknown individuals cohabiting in the same space – co-living and co-housing models of housing. Bajlon asserts that in an apartment, minimum social conditions should ensure the capability to fulfill individual needs (work, rest, isolation, etc.) of each member and the opportunity to engage in communal activities within the family, within the constraints of available resources.[37] Privacy and isolation needs can be met by implementing several design principles: 1) separating the activities of children and parents, 2) segregating children by gender, 3) separating spaces for personal and communal life, 4) implementing a circular connection, and 5) employing separate entrances.

It is advisable to separate the activities of children and parents (or older and younger individuals) because different generations of users have distinct interests, needs, and activity dynamics. Separation can be achieved through physical segregation of activities in space. It is considered necessary for the proper psychophysical development of a child to have closeness to the mother and sleep in the parental room until the age of three, while separating the child into a separate room should be done no later than at the age of six.[38] After the age of thirteen, when the child is in the final phase of personality

35 Lourenco, Longo, and Pathman. "Near Space and its Relation to Claustrophobic Fear."

36 Chappells and Shove, "Comfort: A Review of Philosophies and Paradigms."

37 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*, 35.

38 Dinić, „Analiza odnosa strukture porodice i organizacije i strukture stana," 139.

formation, it is necessary to provide the opportunity for separation from other family members but within the same residential space. In this regard, introducing an auxiliary entrance that enables undisturbed use can achieve a higher level of privacy in the residential space.[39]

Separating children by gender is advisable due to their different psycho-social needs and the dynamics of male and female child development. It is important to ensure equality for children and provide equal spatial conditions for their growth.

Separating spaces for personal and communal living provides the opportunity for both engaging in group activities with family members and meeting individual needs. Preschool-age children require intensive contact with their parents, which gradually decreases by the age of twelve. Children develop a need for periods of privacy in their individual space after the age of thirteen.[40]

Implementing a circular connection and introducing an auxiliary entrance in residential spaces can achieve a higher level of privacy, as users do not disturb each other during different activities. Circular connection allows for alternative movement within the space and reduces the chances of users or visitors encountering each other, which may be undesirable from the parents' perspective but is a characteristic need for adolescents. To ensure adequate spatial independence of individual spaces from communal areas, it is desirable to have the option of forming a circular connection that bypasses the living area or connects one or two rooms directly to the entrance zone.[41]

39 Alfirević and Simonović Alfirević, "Spatial Organisation Concept of Two-Entrance Apartment."

40 Dinić, „Analiza odnosa strukture porodice i organizacije i strukture stana."

41 Alfirević i Simonović Alfirević, „Koncept kružne veze u stambenoj arhitekturi / 'Circular Connection' Concept in Housing Architecture".

2.1.3. Spatial conditions to satisfy belonging needs

The need for belongingness is crucial for the social development of every individual. Communication with other individuals (family and friends) within residential spaces typically occurs in areas designed for gatherings. For a gathering space (living room, multipurpose room, lounge, etc.) to serve its purpose, it must be adequately sized for the expected number of individuals (permanent residents and occasional visitors). In two-generation and three-generation families, it's desirable for gathering spaces to be separate, meaning the residential space should have at least two centers. Having only one center can lead to conflicts, such as overlapping social contacts of younger family members and the reception of adult guests.[42] In residential spaces of middle and lower standards, it's common for the living room to serve as the primary gathering center for users. The dining room may also be utilized as needed, either as a separate unit closely related to the living area or within the so-called "extended circulation area." According to Bajlon, the extended circulation area emerged from the need to create a space for family gathering around a family table when the apartment's limited space does not allow it.[43]

2.1.4. Spatial conditions to satisfy esteem needs

The need for esteem, which encompasses self-respect, achievement, respect for others, and recognition of one's accomplishments, represents a higher level of life needs that are primarily fulfilled through interactions with others and are not directly associated with spatial

42 Montgomery, "The Housing Patterns of Older Families."

43 Bajlon, „Neka pitanja u vezi sa upotrebnom vrednosti stana, stan i stanovanje."

contexts. However, the need to achieve and demonstrate success can be related to the physical environment in certain ways. Individuals may aspire to showcase their success and material status to others by not only maintaining a stylistic identity in their residential space but also by inhabiting or utilizing a large area, including a guest reception area. This serves to artificially create a sense of respect or admiration among others. According to Jelena Ristić, the concept of the structure and design of elite family homes is linked to 'status expectations,' reflecting the need of certain social strata to establish their hegemony and display a particular status position, social values, and lifestyle through the representation of living space.[44]

2.1.5. Spatial conditions to satisfy self-actualization needs

The needs for self-actualization, similar to the previous group of human needs, are considered as higher-level psychological needs that are generally independent of spatial conditions. However, the need for creativity and engagement in creative activities can intersect with the physical context in terms of providing suitable space for undisturbed involvement in activities that contribute to personal fulfillment. Ideally, this involves a dedicated hobby room that caters to various activities, each requiring distinct characteristics depending on their nature. However, in cases of limited space, the hobby area might be integrated into the living room.

By examining and organizing the relationships between characteristic human needs within residential spaces and the means (principles) for meeting them, it is evident that residential environments offer the physical framework for satisfying fundamental human needs, both physiological and psychological. Conversely, higher-level needs are typically met through interactions and engagements beyond the confines of residential spaces (Table 2).

Human needs form a nuanced system of motivations, with some cyclically alternating and complementing each other, such as physiological and partly psychological needs, while others progress and build upon each other, manifesting less frequently. When designing residential space, it is necessary to address not only the satisfaction of constantly present (cyclical) needs, primarily achievable through effective spatial and functional organization, but also consider developmental needs. These latter needs require a flexible spatial layout capable of adapting to their dynamic nature.

Regarding the utility value of residential spaces and strategies for optimizing it, it is essential to highlight that the "ideal" residential space is the one that accommodates the regular and complete fulfillment of most human needs. Key aspects include spaces that facilitate essential life activities, adequately sized to meet users' specific requirements. On the other hand, in the case of collective housing, aspects of privacy and user socialization become very significant.

Another critical factor is the level of furnishing within the space. Inappropriate, non-standard, or oversized furniture can diminish the usable area, impacting spatial comfort and consequently reducing the overall utility value of the residential space.

44 Ristić, „Stambena arhitektura elite kao prostor za performans društvenih vrednosti," 174.

Table 2 An overview of characteristic human needs in housing and the possibilities for their satisfaction

Human needs in residential space		The potentials of residential space for meeting human needs
Physiological needs	The need for air	- Natural or artificial space ventilation
	The need for food and drink	- Space for food storage - Space for food preparation - Dining area
	The need for excretion	- Sanitary facilities (bathroom and/or toilet)
	The need for rest	- Rest area
	The need for sexual relations	- Rest area
Safety and comfort needs	The need for physical security	- Ergonomics of space and furniture
	The need for family security	- Burglary security
	The need for property security	- Burglary security
	The need for material security (employment)	- Working space
	The need for health security and fitness	- Space for maintaining personal hygiene - Space for rest and recreation
	The need for privacy and isolation	- Separation of children and parents - Separation of children according to gender - Separation of rooms for personal and communal life - A circular connection that provides intimate access to the night zone - Living space with two entrances
	The need for comfort	- Optimal room equipment - Optimal room dimensions
Love and belonging needs	The need for belonging and love in the family	- Space for family gathering (living room, dining room, working kitchen, extended circulation area)
	The need for friendship with people outside the family	- Space for receiving guests
Esteem and respect needs	The need for respect in the family	---
	The need for respect outside the family	- Space for receiving guests - Room for accommodation of servants
	The need for self-esteem	---
Self-actualization needs	The need for independent actions	---
	The need for contacts	- Space for gathering
	The need for targeted social activities	---
Knowledge and art needs	The need for knowledge	- Reading space (office, library)
	The need for art	- Working space
Altruism needs	The need to help other people outside the family	---
	The need for engagement in society	---

2.2. Ergonomics

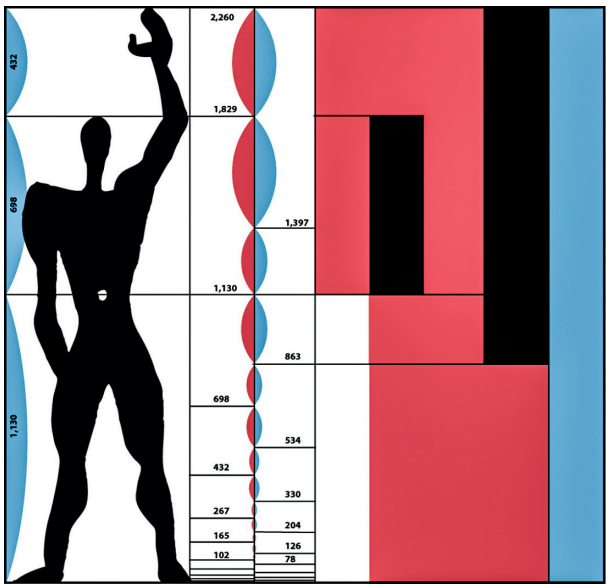


Figure 6 Modulor, Le Corbusier, 1945 (above and below) (Source: Le Corbusier, Modulor 2)

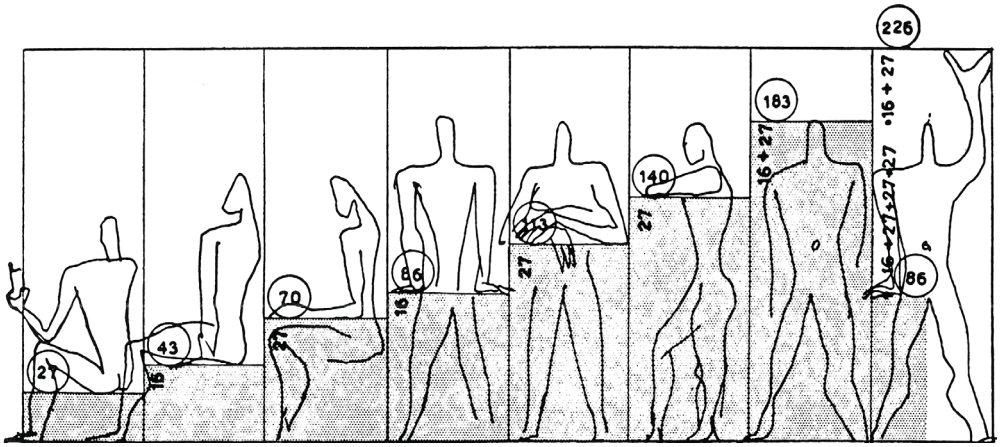
Ergonomics (from Greek *ργον (érgon*) - work) is a term that refers to the design of elements across various human activities to ensure comfortable, efficient, and safe use.[45] It encompasses a scientific discipline that studies and tailors the entire material environment to suit human needs and capabilities.[46]

In architecture, the principle of ergonomics involves adapting spaces, furniture, and equipment to the dimensions and abilities of the human body. When the living environment harmonizes with body proportions or the overall human form, tailored to typical positions or activities, it is regarded as human-centric or humane.

Human scale, a foundational principle in modern architecture, is grounded in the concept that the human body serves as the ultimate measure. The leading protagonist of this idea in architecture is considered to be the architect Charles-Édouard Jeanneret-Gris, better known as Le Corbusier. Around 1945, he championed the Modulor as an anthropometric scale of proportions (Figure 6), drawing inspiration from ancient models

45 Weiner, *Interior Design as a Motivation for Creating Creative Spaces*.

46 Charytonowicz, "Reconsumption and Recycling in the Ergonomic Design of Architecture."; Hjalmarson, *Ergonomics at Home – Design for Safe Living and Home Care*.



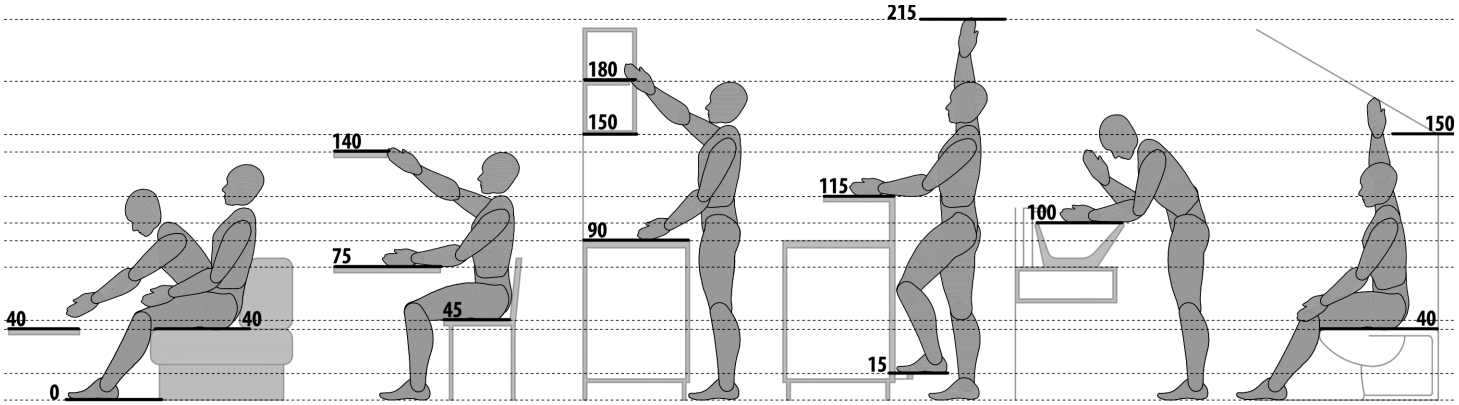


Figure 7 Characteristic heights in relation to basic human positions and activities (Source: Authors' drawing)

found in works by Vitruvius, Leonardo da Vinci, and Leon Battista Alberti. This scale aimed to bridge the gap between the two predominant measurement systems in architecture at the time: the French (metric) system and the Anglo-Saxon (imperial and USC) systems.

Human scale encompasses a range of meanings, reflecting its diverse application in architecture. In a narrower context, it aligns with ergonomic considerations of space and form, ensuring they suit human proportions. In a broader context, it embodies a humanistic ethos in architecture, involving aspects like: a) Harmonizing space and form dimensions with the human figure, b) Incorporating natural materials like wood, brick, or stone, c) Utilizing geometries derived from natural, organic shapes. According to Živoin Karapešić, human scale involves adhering to empirical measures of the human figure across different positions and aligning space dimensions with human body proportions and object dimensions within that space. It's also a material manifestation of functionalist ideals, emphasizing convenient human-object interactions.[47]

47 Karapešić, „Arhitekt na delu", 40.

Fundamentally, the golden ratio or divine proportion underpins considerations of human body dimensions in architecture. The golden ratio is a proportional relationship in which the ratio between two quantities is equal to the ratio of the sum of those two values to the larger value, approximately equal to 1.618. The golden ratio is present in everything that surrounds us, from natural and organic forms to artificial creations.

Contemporary architectural and design approaches are rooted in addressing functional needs and rely on applying principles of ergonomics and anthropometry. These disciplines primarily consider key human body dimensions like width and depth, which serve as foundational metrics from which others are derived. Human body dimensions used in architecture are typically categorized into structural and functional dimensions. Structural dimensions, also known as "static" dimensions, pertain to the human body at rest. They are crucial when determining spatial requirements for activities such as sitting, standing, or lying down. On the other hand, functional dimensions, termed "dynamic," relate to the human body in motion while engaging

in activities like walking, kneeling, or crawling. These dynamic dimensions play a vital role in establishing spatial dimensions necessary for accommodating various human movements within architectural spaces.

2.2.1. Form adaptation to human body dimensions

When designing residential spaces, various dimensions are applied derived from characteristic static or dynamic positions of the human figure during the performance of specific residential functions. These characteristic heights are crucial in ensuring the smooth execution of various activities within residential areas. They are illustrated in the Figure 7 and arise from passive or active states, such as: sitting in the living room (h=40cm), sitting on a work or dining chair (h=45cm), dining at the dining table or performing work activities at a desk (h=75cm), reaching items from a shelf while sitting on a chair (h=140cm), meal preparation at a kitchen counter (h=90cm), reaching items from an overhead cabinet in the kitchen (h=180cm), standing at a countertop (h=115cm), washing in a sink or bathroom (h=90cm), and sitting on a toilet bowl (h=40cm). These heights correspond to specific activities and furniture elements within a residential space, ensuring that users can comfortably and efficiently carry out their daily tasks without physical strain or discomfort (Figure 7).

All the mentioned heights are averages and vary within different ranges depending on population categories, gender, age, national characteristics, etc.[48] Furniture elements (movable and built-in) designed for residential spaces are adjusted to the aforementioned average heights according to the needs and physical characteristics of users. In addition to the mentioned dimensions, many other dimensions (heights, lengths, widths) are used that further determine the characteristics of utility elements (furniture and equipment). Research on these dimensions belongs to the field of anthropometrics. Anthropometry (from Greek anthropos - human and metron - measure) is a scientific field that deals with measurements of the human body, its parts, and functional abilities. Measurements are taken on the human body or on models in the form of skeletons. Distances between individual points on the body and angles that determine specific positions and lines of the body are measured.[49]

2.2.2. Space adaptation to human body dimensions

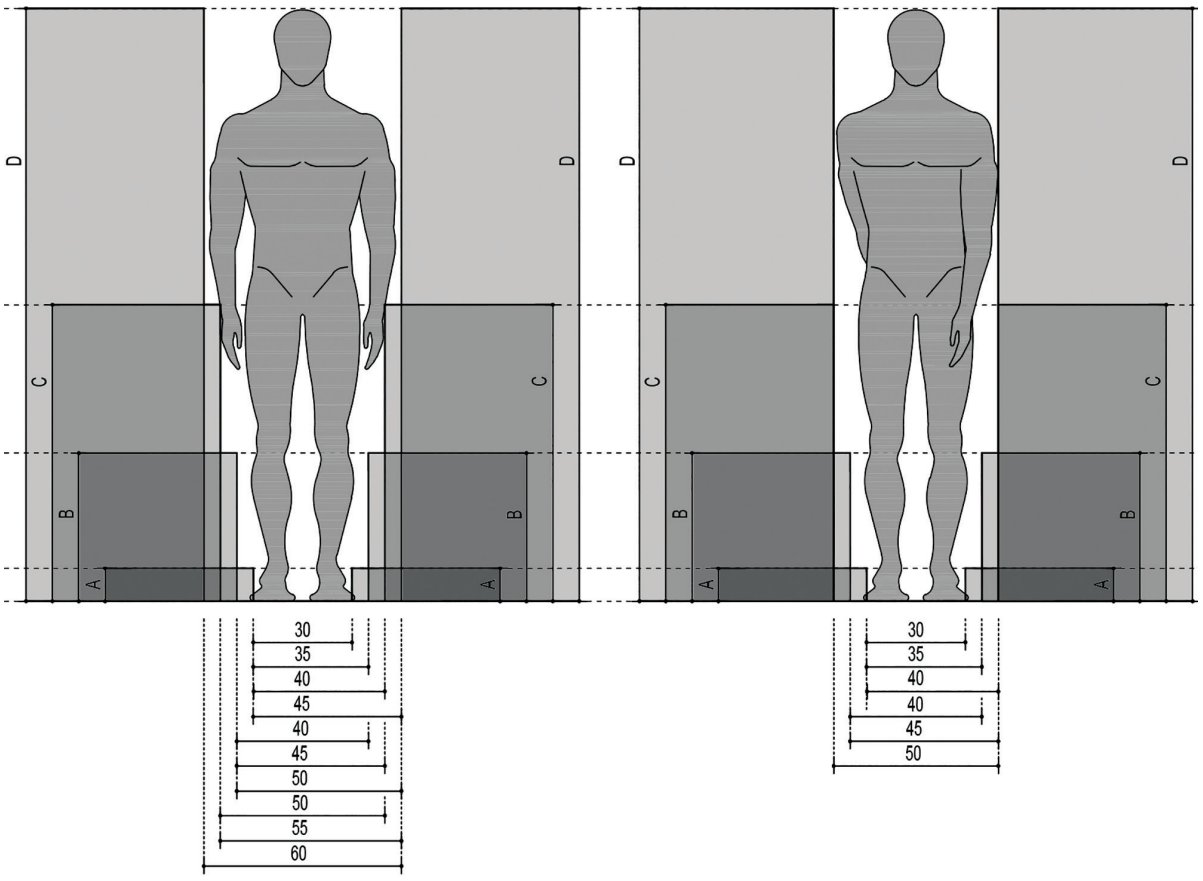
Anthropometric measurements play a crucial role in defining open spaces and passages within residential areas, providing essential input for determining optimal dimensional parameters. It is important to emphasize that average measurements are not always used in the spatial dimensioning process; instead, depending on the case, minimal, median, or maximal dimensions are applied.[50] Residential spaces are sometimes dimensioned considering various body types, such as short, tall, or corpulent individuals, and sometimes, wheelchairs are also taken into account. During the 1970s, the IMS Housing Center in Serbia conducted scientific research that was based on the comparison

48 Panero i Zelnik, *Antropološke mere i enterijer: Zbirka preporuka za standarde u projektovanju*; Čanak, „Slobodni prostori i prolazi u prostorijama"; Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

49 Kralj, *Antropometrija*.

50 Čanak, „Slobodni prostori i prolazi u prostorijama."

Figure 8 Minimum space dimensions in relation to the basic human positions (right) (Source: Authors' drawing according to Čanak, „Slobodni prostori i prolazi u prostorijama," 16)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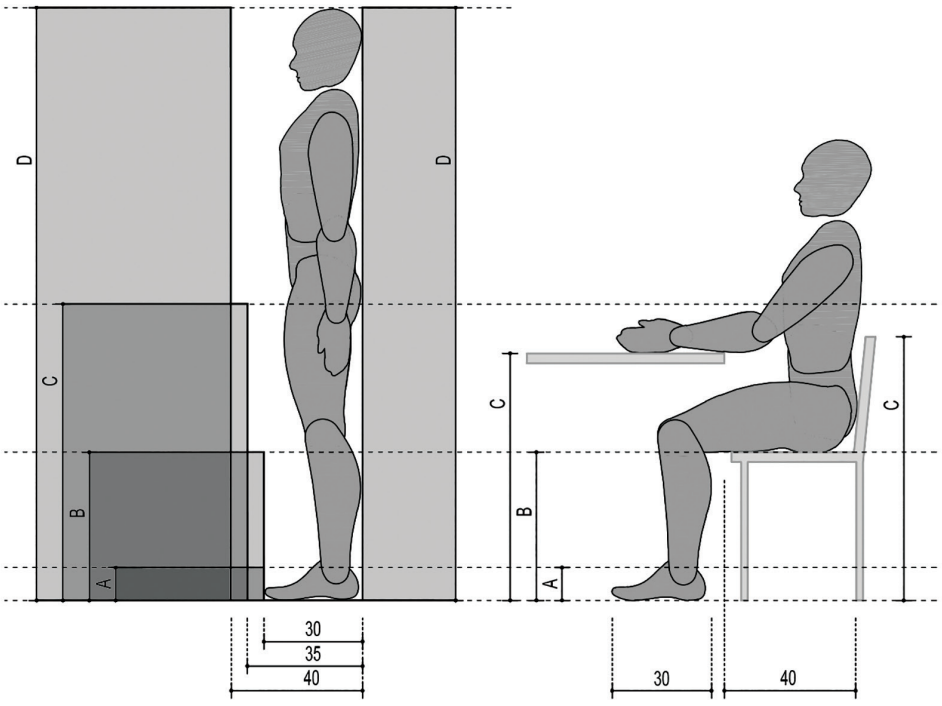
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of foreign anthropometric studies and empirical research organized within the Center. The results from these studies identified four specific heights of vertical surfaces and elements that are crucial in determining residential space. (Figure 8) These specific heights serve as a basis for dimensioning free spaces within an apartment, providing a structured approach to spatial design and accommodation:[51]

A) ankle height (shoes, shower base, step),

B) knee height (chair or armchair seat, bed, toilet seat, bathtub, bidet, etc.),

C) hip height (chair backrest, table, work surface, sink, stove, low refrigerator, laundry and drying machines, dishwasher, dressers, etc.),

D) shoulder and upper body height (wardrobes, closets, tall refrigerator, walls, etc.).

The research conducted by the Institute of Housing of IMS provided valuable insights into establishing standard minimum and maximum widths for rooms in apartments. The summarized results of this research are systematized in Figure 9, categorizing the dimensions of characteristic residential spaces based on four value criteria: absolute minimum, functional minimum, economic maximum, and absolute maximum. According to Čanak:

„*The absolute (or critical) minimum* represents a quality threshold below which a function cannot be adequately performed, or its performance is severely hindered due to spatial limitations, leading to a negation of its purpose. (...) *The functional minimum* signifies a level of spatial quality below which residential functions face significant difficulties due to a decrease in overall quality."[52]

While the research does not explicitly define economic and absolute maximum criteria, it can be assumed that the *economic maximum* represents a level of spatial quality that allows residential functions to be performed smoothly without excessive space usage or luxury. Similarly, the *absolute maximum* denotes the upper limit of quality where spatial luxury and impractical use begin to outweigh functional benefits.

51 Čanak, „Slobodni prostori i prolazi u prostorijama"; Čanak, „Dimenzionisanje prostora i prostorija u stanu 1"; Čanak, „Dimenzionisanje prostora i prostorija u stanu 2".

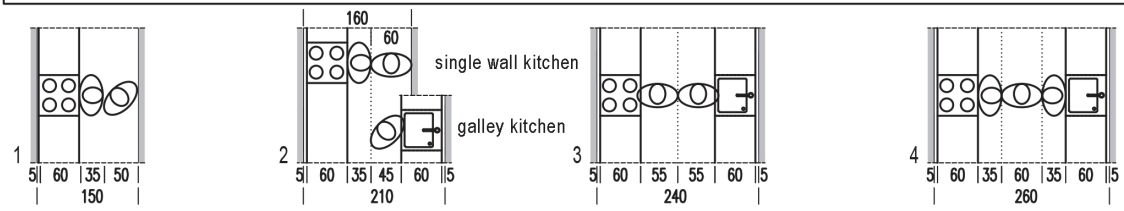
52 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*, 250.

Figure 9 Overview of standard minimum and maximum room widths in apartments (right) (source: Gavrilović, Funkcionalni aspekti veličine stana; Čanak, „Slobodni prostori i prolazi u prostorijama.")

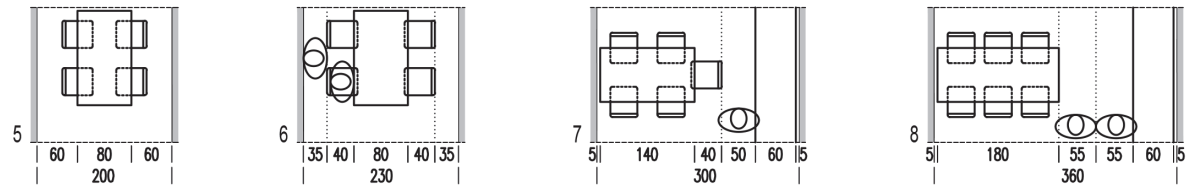
OVERVIEW OF STANDARD MINIMUM AND MAXIMUM ROOM WIDTHS IN APARTMENTS

Absolute minimum	Functional minimum	Economic minimum	Absolute maximum

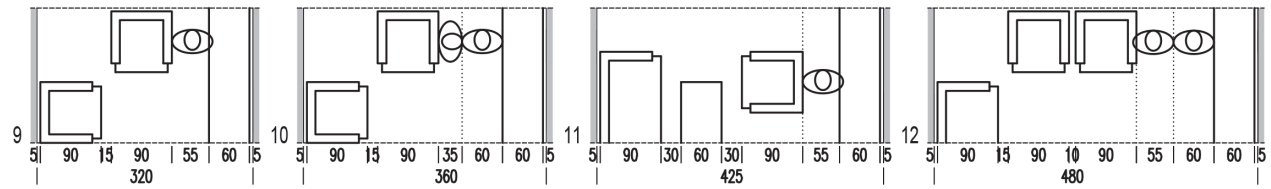
K - KITCHEN



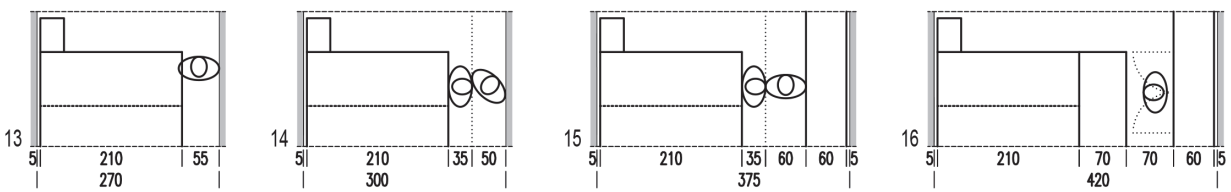
D,KD - DINING ROOM, KITCHEN WITH DINING



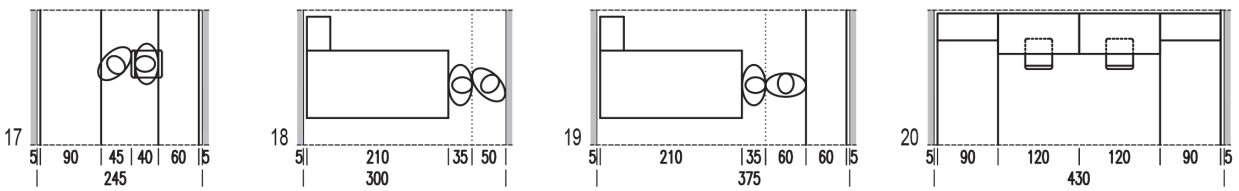
LR - LIVING ROOM



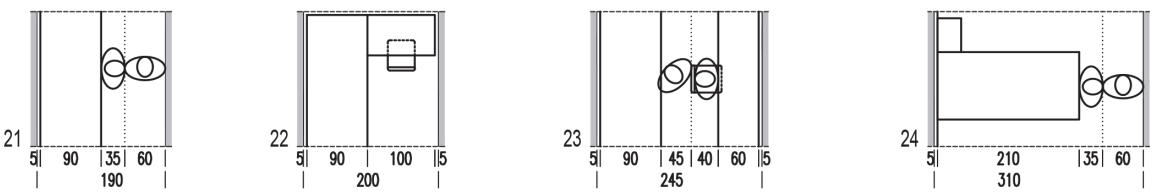
MR - MASTER ROOM

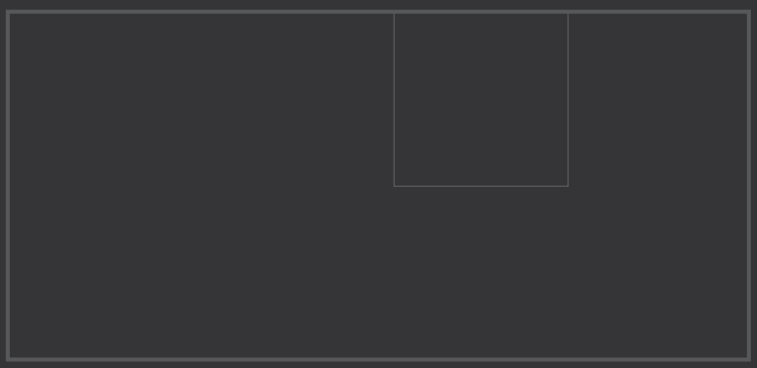


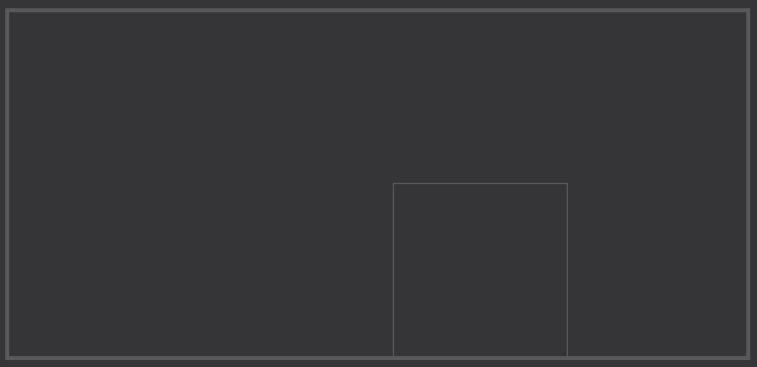
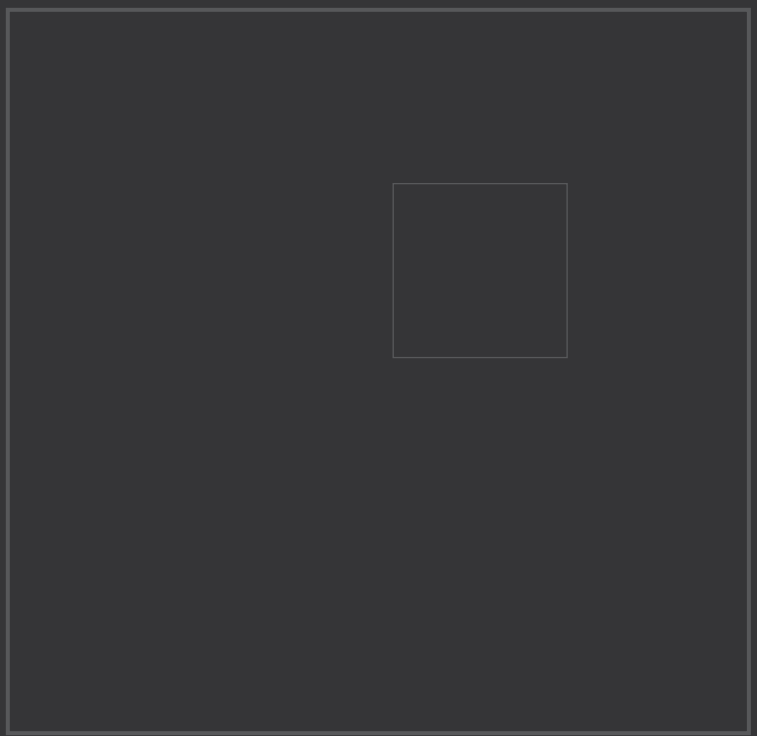
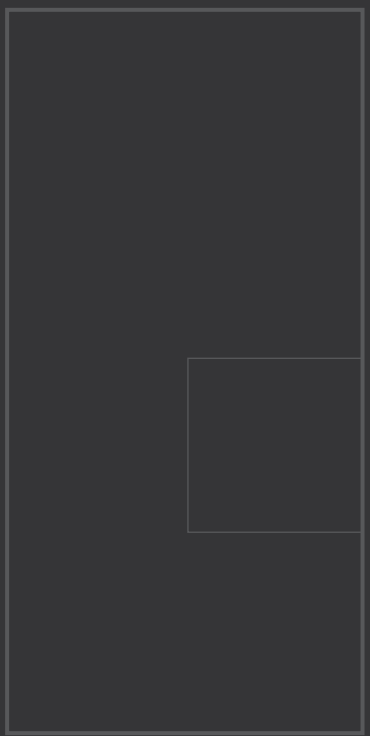
R2 - ROOM WITH TWO BEDS



R1 - ROOM WITH SINGLE BED






III STRUCTURAL PRINCIPLES

Structural principles encompass the attitudes and determinations relevant to designing relationships among residential functions and the appropriate composition of residential space. For these relationships to materialize, there must be potential connections, ensuring that certain functions do not conflict when connected directly. Depending on whether a residential function is aggressive, neutral, or sensitive to other functions, their relationships can be either constant or temporary. This dynamic nature indicates a pulsating system of establishing or abolishing connections, highlighting the variable structure of the space.

3.1. Compatibility of functions

The most significant structural principle shaping the spatial structure's character is the compatibility of functions. This principle revolves around establishing potential relationships between residential functions based on their aggressiveness, neutrality, or sensitivity. Aggressive functions are those whose operation negatively affects other functions by disrupting or preventing their functioning. On the other hand, a neutral relationship between functions implies that they do not interfere with each other; their interaction can be bidirectional, meaning a function neither disrupts others nor is disturbed by them. Sensitive functions are those vulnerable to the influences of other functions, where their operation can disrupt or prevent proper functioning.[53] (Figure 10)

The compatibility of residential functions within a system implies a harmonious relationship between two or more functions, allowing for their joint operation (or duration) in the same space. When functions are compatible, the connections between them can be permanent, allowing them to occur in the same space following an open-plan principle or in separate, directly connected spaces. On the other hand, if functions are not compatible, the connections must be intermittent and controlled, necessitating spatial separation or functional segregation.

Aggressive residential functions include: 1) excretion – due to auditory, olfactory, and visual disturbances, 2) bathing – due to auditory and visual disturbances, 3) viewing or listening to media – due to auditory disturbances, 4) sexual activities – due to auditory and visual disturbances, 5) social contacts – due to auditory disturbances, 6) undressing and dressing – due to visual disturbances, 7) conversation – due to auditory disturbances, 8) food storage – due to olfactory disturbances, 9) waste disposal – due to olfactory, visual, and hygiene disturbances, 10) machine laundry – due to auditory disturbances, and 11) animal husbandry – due to auditory and hygiene disturbances. Although many of these functions can occur at acceptable intensities or forms, in numerous situations, it is necessary to strictly and controlledly separate them from other residential functions due to potential functional conflicts that may arise. Sensory residential functions include: 1) excretion – due to visual disturbances, 2) bathing – due to visual disturbances, and 3) sexual activities – due to visual disturbances.

53 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

		AGGRESSIVENESS toward functions				NEUTRALITY toward functions				SENSITIVITY toward functions				NEUTRALITY toward functions			
		Disturbances				Disturbances				Disturbances				Disturbances			
		Noise	Olfactory	Visual	Hygienic	Noise	Olfactory	Visual	Hygienic	Noise	Olfactory	Visual	Hygienic	Noise	Olfactory	Visual	Hygienic
Active (primary) functions	Sleep	○				○	●	●	●	●	●		●			●	
	Rest					●	●	●	●	●	●	○	●			○	
	Using the toilet	●	●	●					●			●	●	●	●		
	Eating		●		●	●		●			●		●	●		●	
	Washing up	○				○	●	●	●				●	●	●	●	
	Bathing	●		●	○		●		○			●	●	●	●		
	Shaving, cosmetics	○			○	○	●	●	○				●	●	●	●	
	Gymnastics					●	●	●	●				●	●	●	●	
	Recreation	○			○	○	●	●	○	○	●		●	○		●	
	Media consumption	●					●	●	●	●	●		●			●	
	Reading, writing					●	●	●	●	●	●		●			●	
	Sexual relations	●		●			●		●	●	●	●	●				
	Family member care	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	
	Contacts	●					●	●	●	●	●		●			●	
Active (secondary) functions	Dressing, undressing			●		●	●		●			●	●	●	●		
	Food preparation	○	●		●	○		●			●		●	●		●	
	Serving		○			●	○	●	●		●		●	●		●	
	Hand washing dishes	○			●	○	●	●			●		●	●		●	
	Hand washign laundry	○			○	○	●	●	○				●	●	●	●	
	Ironing laundry					●	●	●	●				●	●	●	●	
	Apartment maitenance	○			●	○	●	●						●	●	●	●
	Communicating	○		○		○	●	○	●								
	Isolation					●	●	●	●	○	●	○	●	○		○	
	Conversation	●					●	●	●	●					○	●	●
Passive functions	Clothing storage					●	●	●	●		●		●	●		●	
	Food storage		●			●		●	●		●		●	●		●	
	Kitchenware storage					●	●	●	●				●	●	●	●	
	Trash disposal		●	●	●	●							●	●	●	●	
	Machine dishwasing	●					●	●	●				●	●	●	●	
	Machine laundry washing	●					●	●	●				●	●	●	●	
	Household item storage					●	●	●	●				●	●	●	●	
	Item storage		○		○	●	○	●	○				●	●	●	●	
	Animal husbandry	●	●		●			●		○			●	○	●	●	
	Book storage					●	●	●	●				●	●	●	●	

Legend:
○ - Occur occasionally
● - Occur constantly

High level of disturbance or sensitivity
Medium level of disturbance or sensitivity
Low level of disturbance or sensitivity

Figure 10 Aggressiveness and sensitivity of residential functions (Source: Authors' drawing based on Čanak, Funkcionalna koncepcija i upotrebna vrednost stana, 175) (The table presented is derived from the Mihailo Čanak's study of the same name. The original table, which listed only the frequencies of residential functions, has been expanded to include a depiction of the varying degrees of aggressiveness or sensitivity associated with these functions.)

If we establish a hierarchy of residential functions based on their aggressiveness or sensitivity in relation to other functions, it becomes evident that the most aggressive residential functions encompass activities such as excretion, waste disposal within the apartment, animal husbandry, bathing, food preparation, food consumption, sexual activities, and family care. Conversely, the most sensitive functions include sexual activities, rest, sleep, intellectual work, social contacts, and isolation.[54]

All disruptions and sensitivities affecting residential functions can vary in intensity. Certain levels of disruption may be tolerable during short or extended periods of space usage, as users might accept them based on specific hierarchies of their needs or other reasons. However, for certain disruptions, it becomes essential to separate residential functions or establish controlled and occasional connections. The outlined system of disturbances is highly subjective and relies on numerous personal factors. What may be an intolerable disturbance for one user in a space could be viewed as less significant or insignificant by another individual.

It is important to highlight that as human needs in residential spaces evolve dynamically, so do the intensities of disturbances that come with them. The necessity to partition residential spaces into multiple spatial units (rooms) directly stems from the disruptions that certain functions can cause to others, making it impossible to carry out two or more incompatible functions in the same space.

3.2. Interconnection of functions

The principle of interconnection involves the mutual linking of residential functions based on spatial and temporal relations. Depending on whether functions must, can (under certain circumstances),[55] or cannot take place in the same space or simultaneously, their potential relations can be represented as follows (Table 3):

54 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

55 In his research (Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.) Mihailo Čanak makes a distinction between the possibility of separating residential functions and the possibility of separation under certain conditions. Although the existence of such differences is apparent, in this monograph, functions are not separated in the mentioned manner but solely based on aspects of spatial and temporal interconnectedness for clarity and easier comprehension.

Table 3 Spatial and temporal interconnection of functions

		Spatial connectivity		
		must be established	can be interconnected	cannot be connected
Temporal connectivity	must be	must be in the same space, must be at the same time	it can be in the same space, it must be at the same time	it cannot be in the same space, it has to be at the same time
	can be	must be in the same space, can be at the same time	it can be in the same space, it can be at the same time	it cannot be in the same space, it can be at the same time
	cannot be	must be in the same space, cannot be at the same time	it can be in the same space, it cannot be at the same time	it cannot be in the same space, it cannot be at the same time

Of particular importance for spatial configuration is the relationship between residential functions that cannot occur in the same space, requiring their occasional or constant segregation. Depending on the number of undesirable relationships that should not be realized in the same space, residential functions can be classified into four categories: (Figure 11)

1) Highly intolerant functions - bathing [18], food storage [18], toileting [17], food preparation [17], hand dishwashing [17], hand laundry [16], and waste disposal [15];

2) Considerably intolerant functions - sexual intercourse [13], machine dishwashing [13], and sleeping [12];

3) Moderately intolerant functions - resting [10], socializing [10], clothing storage [10], book storage [10], kitchenware storage [9], recreation [9], pet care [9], reading and writing [9], food serving [9], machine laundry [9], dining [7], dressing and undressing [7];

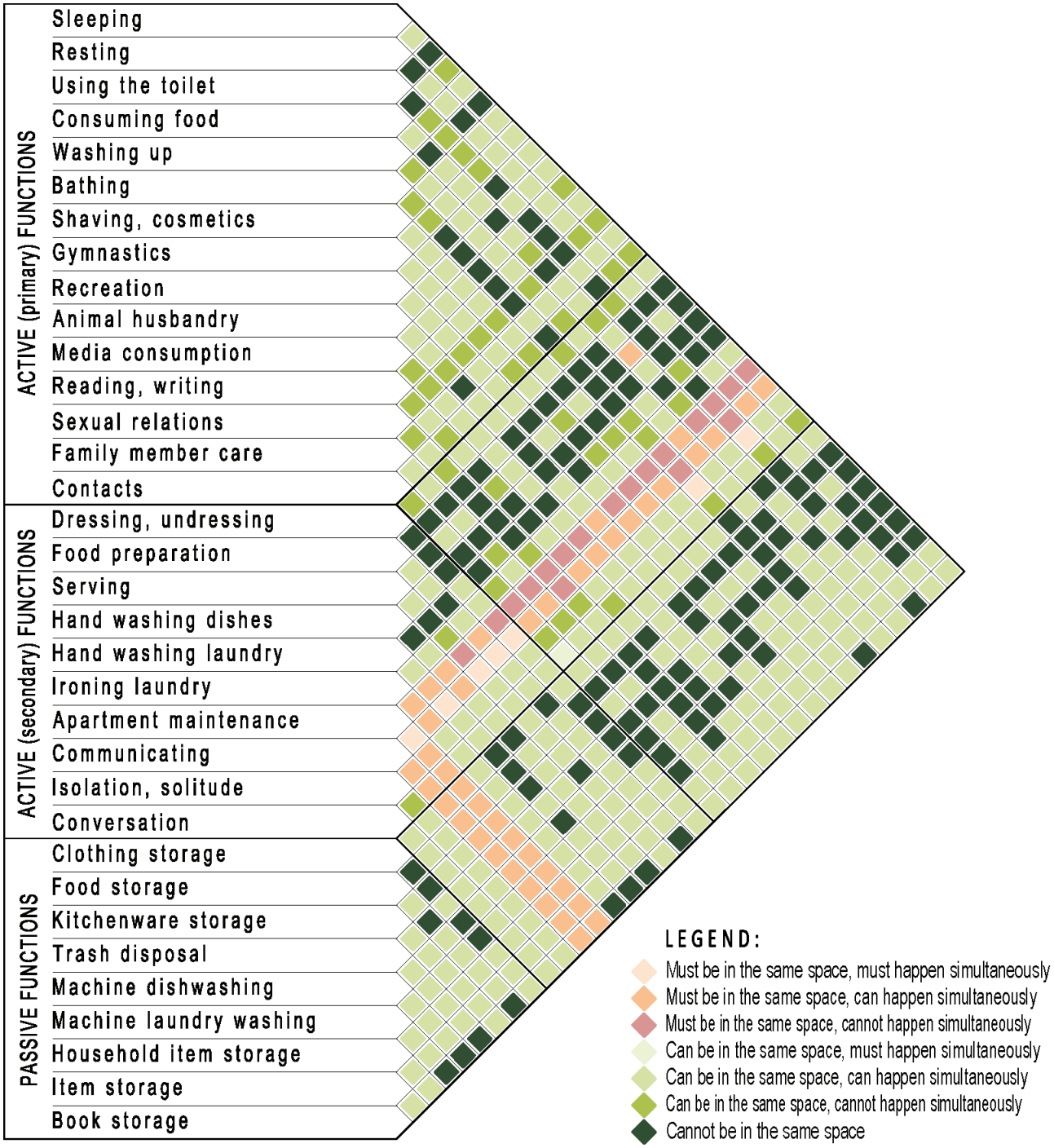
4) Tolerant functions - washing [5], family care [5], shaving and grooming [4], exercising [4], media consumption [4], storage of maintenance tools [4], ironing [2], various item storage [0], house maintenance [0], communication [0], solitude and isolation [0], conversation [0], etc.[56]

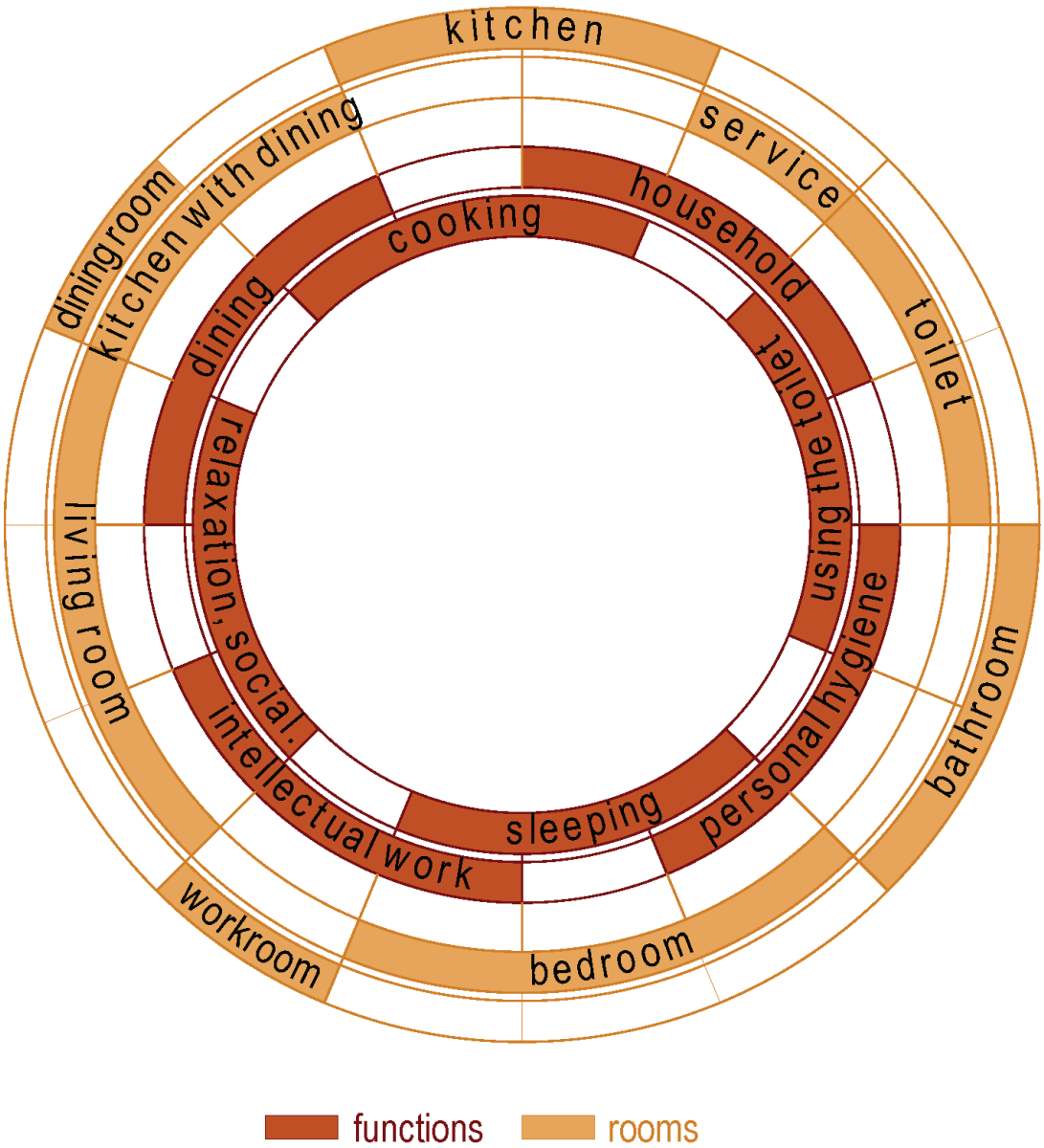
Based on the presented data, it is noticeable that the majority of residential functions fall into the tolerant category, or range from moderately to considerably intolerant towards other functions, suggesting a higher potential for combining them in the same space. Conversely, exclusive (highly intolerant) functions require strict segregation from other functions within the space. It is also apparent that highly intolerant residential functions are typically grouped into two units, spatially forming the sanitary and kitchen blocks (often referred to as the "technical block").

The interconnection of functions significantly relies on the category of space users, as the interdependence and intensity of residential functions directly shape the nature of the housing structure. The level of function intolerance decreases when space users are of the same or similar generations, as well as with parents having young children, whereas complications arise with users of different generations. In permanent housing, it is crucial for functions to be appropriately connected, unlike in temporary housing (such as weekend houses or vacation homes) where various compromises may be acceptable, including at times connecting incompatible functions to achieve other objectives and conveniences. Generalizing the possibilities of connecting residential functions shown in the previous figure leads to a system of common relationships between functions and spaces in residential areas depicted in the Figure 12. From the illustration provided, it is evident that some spaces offer the potential for combining two or more residential functions, resulting in the emergence of multifunctional spaces and the concept of an "open plan," which will be discussed later. This system of combining residential functions is certainly not exhaustive, as it does not include a certain number of ancillary spaces commonly found in residential areas (such as a pantry, living room, library, study, media room, etc.).

56 The numbers in angular brackets following the functions represent the occurrences of unfavorable interactions with other functions within the residential space, as illustrated in Figure 11.

Figure 11 Spatial and temporal relations of residential functions (Source: Authors' drawing based on Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*, 177.)


ACTIVE (primary) FUNCTIONS
Sleeping
Resting
Using the toilet
Consuming food
Washing up
Bathing
Shaving, cosmetics
Gymnastics
Recreation
Animal husbandry
Media consumption
Reading, writing
Sexual relations
Family member care
Contacts
ACTIVE (secondary) FUNCTIONS
Dressing, undressing
Food preparation
Serving
Hand washing dishes
Hand washing laundry
Ironing laundry
Apartment maintenance
Communicating
Isolation, solitude
Conversation
PASSIVE FUNCTIONS
Clothing storage
Food storage
Kitchenware storage
Trash disposal
Machine dishwashing
Machine laundry washing
Household item storage
Item storage
Book storage
LEGEND:
Must be in the same space, must happen simultaneously
Must be in the same space, can happen simultaneously
Must be in the same space, cannot happen simultaneously
Can be in the same space, must happen simultaneously
Can be in the same space, can happen simultaneously
Can be in the same space, cannot happen simultaneously
Cannot be in the same space


kitchen
service
toilet
bathroom
bedroom
workroom
living room
diningroom
kitchen with dining
cooking
household
using the toilet
personal hygiene
sleeping
intellectual work
relaxation, social.
dining
functions
rooms

3.3. Temporal relations

The temporality of relationships within the structure is inherent in the variable nature of residential functions. The principle of temporality underscores a dynamic tendency toward alternating and incorporating functions within residential spaces, leading to a flexible residential structure. Residential functions naturally vary, with some occurring simultaneously in the same space, while others follow one another successively or combine within the same area. An enhanced understanding of the dynamism of the residential structure comes from discerning the rhythm (temporal frequency) and duration (time span) of residential functions.[57]

3.3.1. Rhythm of functions

The rhythmicity of functions refers to the periodic alternation of residential functions, occurring at intervals that are predictable or planned. Depending on their recurrence period, functions can be categorized as short-term (daily), medium-term (weekly), and long-term (monthly or yearly). Daily activities include fundamental life functions like sleeping, resting, personal hygiene, meal preparation, and dining, along with secondary tasks such as light housekeeping, dishwashing (manual or machine), dressing, and grooming. Weekly activities encompass more extensive house maintenance, laundry, ironing (manual or machine), and similar tasks. On longer timeframes, monthly or yearly activities such as celebrating birthdays and holidays, window cleaning, furniture and appliance maintenance, caring for the sick, etc., take place. These long-term functions are sometimes seen as variable or irregular since they occur infrequently and are often not predictable in their timing.[58]

Residential functions follow specific characteristic life rhythms (regimes) that depend significantly on human habits and family structure. Thus, we can recognize the following typical daily activity patterns:

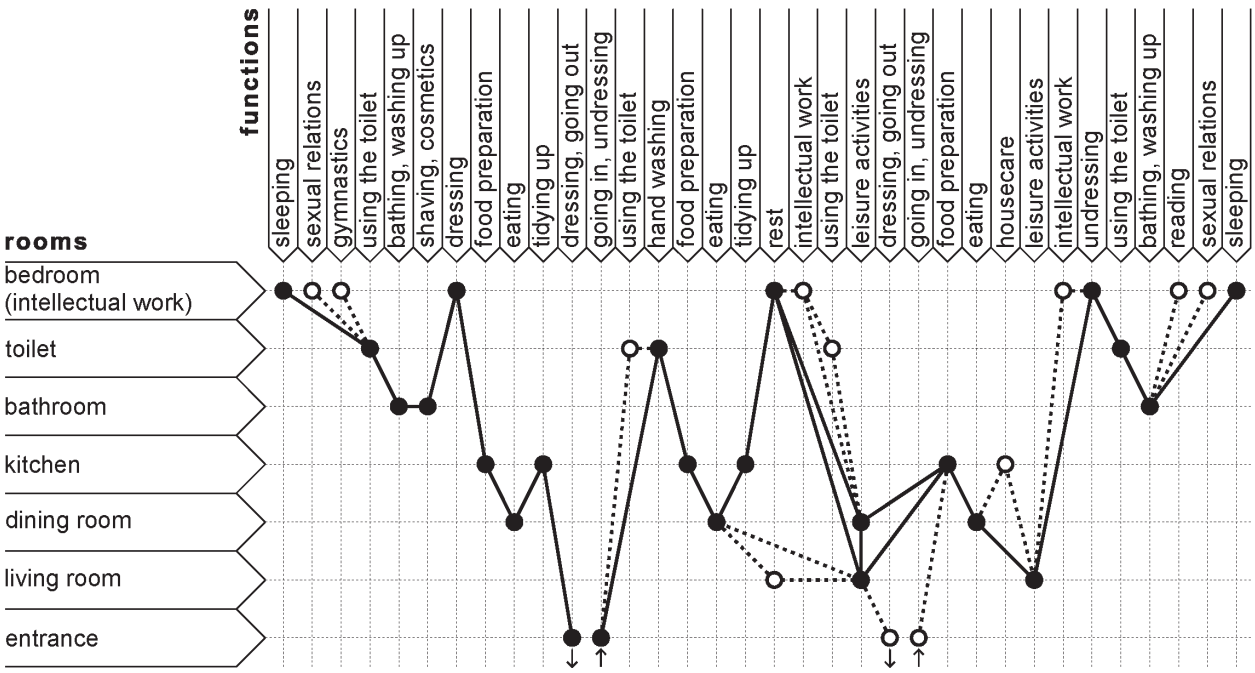
1) Model of typical daily family activities where both parents are employed,
2) Model of typical daily family activities where the father is employed and the mother is not working,
3) Model of typical daily family activities where the mother is employed and the father is not working,
4) Model of typical daily family activities where both parents are employed (child goes to school), etc.

Numerous combinations of the mentioned models provide insights into the functioning of everyday family activities. Some additional models have been explored within scientific studies conducted by the IMS Center for Housing. (Figure 13) Understanding life activities is crucial, especially when designing residential spaces for known users with specific habits. Analyzing such models can reveal the frequency of use of individual rooms in the apartment, thereby guiding design decisions that adequately respond to their needs.

Figure 12 Relationship between residential functions and spaces (Source: Authors' drawing based on Čanak, *Svi moji stanovi*, 15)

57 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

58 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.



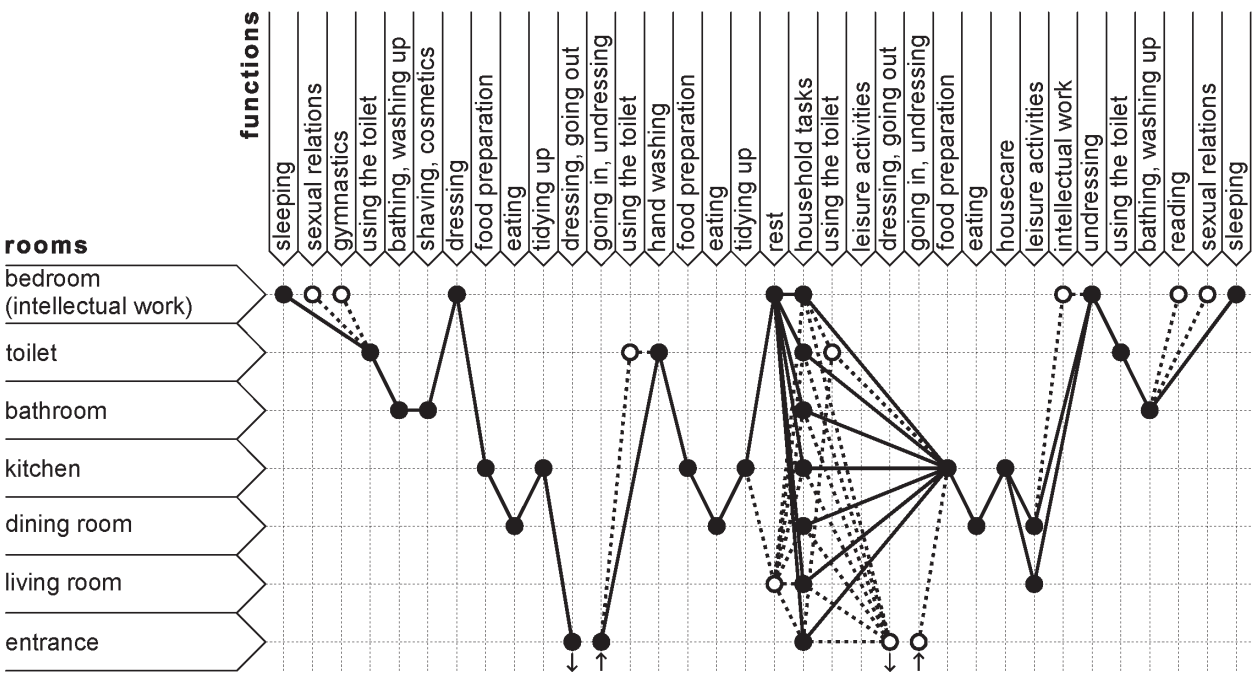


Figure 13 Model of typical daily activities of a working father in a family where the mother is employed (above) and Model of typical daily activities of a working mother (below) (Source: Authors' drawing based on Čanak, *Svi moji stanovi*, 49)

3.3.2. Duration of functions

The duration of a function refers to the time it takes for a specific residential activity to occur. Residential functions can be categorized based on their duration:[59]

1) *Instantaneous functions,* lasting up to 1 minute (standing up, sitting down, entering, exiting, putting on shoes, turning on/off lights, handling, opening and closing doors and windows, etc.);

2) *Short-term functions,* lasting from 1 to 15 minutes (washing up, using the toilet, showering, having breakfast, dressing, shaving, applying cosmetics, etc.);

3) *Medium-term functions,* lasting from 15 to 60 minutes (lunch, bathing, intellectual work, preparing simple meals, sexual relations, dishwashing, laundry, etc.);

4) *Long-term functions,* typically lasting from 1 to 12 hours (sleeping, intellectual work, receiving visitors, preparing complex meals, resting, media consumption, etc.);

5) *Continuous functions*, with an indefinite duration (food storage, household item storage, kitchenware storage, etc.).

The regular repetition and duration of functions reflect the frequency of their use and thus highlight the importance of specific connections between functions. When there is a frequent or repetitive need for communication between spaces where certain residential functions take place, it warrants a more direct connection between these spaces. On the other hand, if the interactions are occasional or irregular, functions can be linked indirectly through flexible and intermittent connections. (Figure 14)

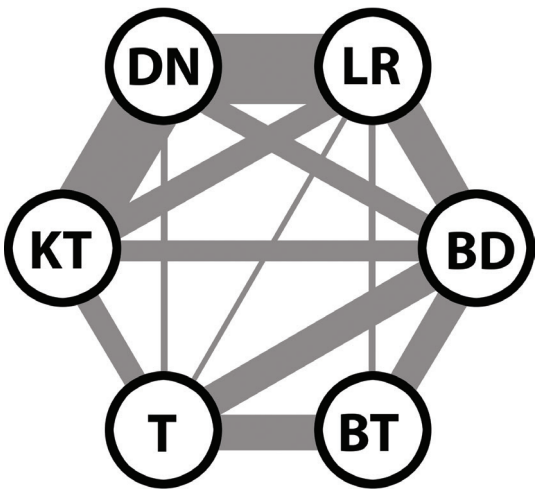
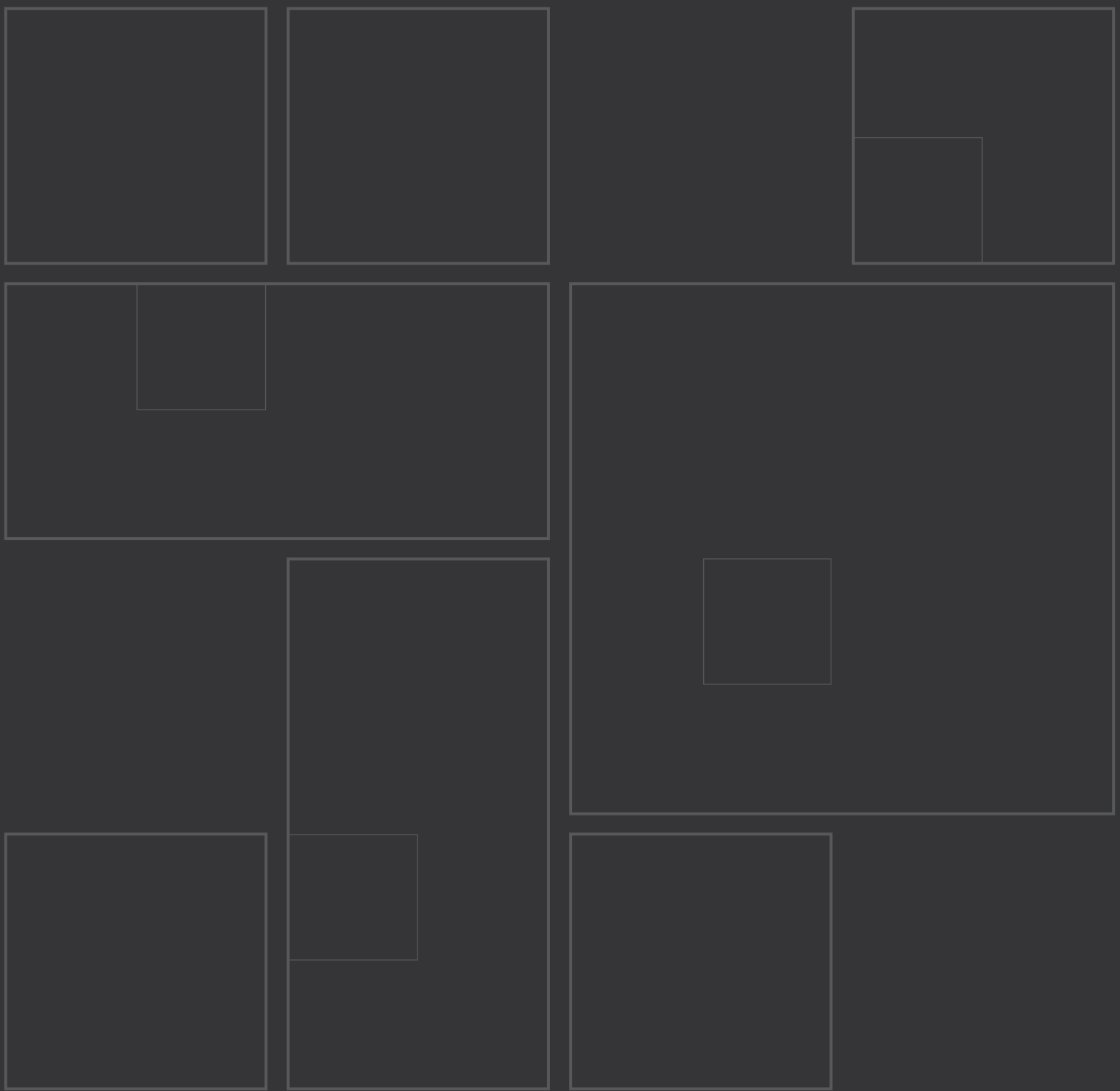


Figure 14 Overall family movement frequencies in the apartment (DN - Dinning area, LR - Living room, KT - Kitchen, BD - Bedroom, T - Toilet, BT - Bathroom) (Source: Authors' drawing based on Čanak, *Svi moji stanovi*, 49)

The scheme presented highlights the most frequent connections within the residential space. It is notable that the living room (LR) is most often connected to the dining area (DN) and the kitchen (KT). Secondary connections occur between the living room and bedroom (BD), bedroom and bathroom (BT), bedroom and toilet (T), as well as between the bathroom and toilet. Conversely, connections between other functions within the residential space show a lower frequency. Given the high level of movement frequency observed between the living room, dining area, and kitchen, it is advisable not to have permanent barriers between them or to ensure that any barriers are flexible. In contrast, fixed or flexible barriers may be appropriate between the other functions to accommodate their lower interaction frequency.

59 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana.*



IV ORGANIZATIONAL PRINCIPLES

Organizational principles encompass decisions and arrangements regarding the placement, grouping, and distinction of residential functions with specific motives or aims. Stemming from fundamental human needs, "individual elements of an apartment tend to cluster complementary activities and functions, creating zones of interconnected spaces that vary in rhythm and usage, some complementing each other while others remain separate due to their inherent programmatic differences."[60] The motives guiding the organization of residential spaces are diverse and influenced by factors such as human needs, architectural concepts, and immediate surroundings. The largest category of organizational principles focuses on how functions are grouped, integrated, or differentiated, as these directly shape the internal structure of a space. Conversely, principles that influence the placement and versatility of functions within residential areas are less commonly applied but still hold significance.

4.1. Grouping of functions

Residential functions can be organized into spatial units, functional units, and spatial-functional units. Each residential function, when it exists independently within a room, constitutes a spatial unit defined by the physical boundaries of that room. When functions are in proximity but separated by walls or partitions, they form a "grouped" functional unit. Conversely, when functions are integrated within the same space, following the open plan principle, they create a spatial-functional unit. Functional units can be classified in various ways depending on the nature of the spaces being grouped. This classification includes dual divisions such as daytime and nighttime zones, or common and individual spaces, as well as triple divisions like common spaces, individual spaces, and household spaces. More complex divisions exist when additional functional groups like communication zones, service zones, recreation and leisure zones, and non-residential zones are included.[61] In the following sections, we will delve into characteristic functional units and explore their grouping concepts commonly encountered in residential architecture, which result from diverse interactions among residential functions.

4.1.1. Arrangement of functional groups in relation to entrance position

The entrance is a highly significant space within a dwelling. As noted by Vladimir Lojanica, it serves as a 'gateway,' delineating the boundary between the external world and the private domain of the dwelling. Its function is dual in nature: it acts as a physical barrier guarding against external influences and provides a space for psychological preparation during social interactions and transitions within the dwelling's spatial environments.[62]

60 Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*, 221.

61 Stoiljković, *Projektovanje stambenih zgrada: Porodično stanovanje*.

62 Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*, 221.

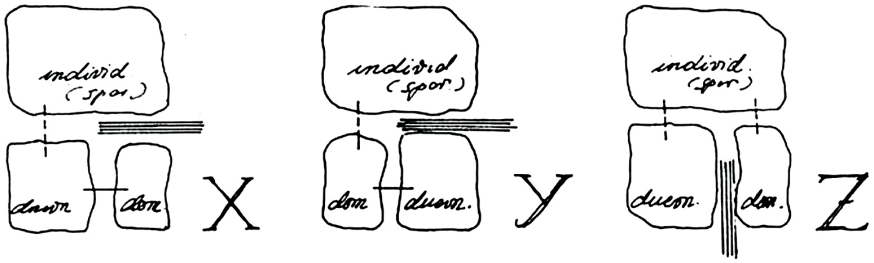


Figure 15 Possibilities of connecting functions - spaces in the apartment in relation to the direction of entry movement (Source: Bajlon, *Stanovanje: Tema 1 – Organizacija stana,* 40)

In multi-family residential buildings, the entrance to an apartment is commonly accessed directly from shared areas such as hallways, elevators, staircases, or other communal areas. Lojanica highlights the significance of entrance position in effectively organizing residential functions and optimizing movement pathways.[63] The drive for cost-efficient construction often leads to minimizing communal communication zones, which can hinder additional entry points to apartment spaces. Smaller apartments typically feature a single entrance/exit, whereas larger ones often have multiple entry/exit points. Depending on layout, design, and user preferences, doors may lead directly outside or indirectly through transitional spaces like entrance halls, hallways, vestibules, or foyers. The term "transitional space" or "mediator space"[64] in architecture refers to an auxiliary space whose primary purpose is to connect two or more main spaces. Functionally, transitional spaces can serve as transit areas (connecting spaces), preparatory areas (transitional spaces), or waiting areas. They may be positioned between external and internal spaces, between internal areas, or between external zones.[65]

In the field of science, numerous studies have explored the organization of residential space and its impact on various aspects such as the utility value of dwellings, housing quality, achieving residential comfort, compatibility of residential functions, structural systems, flexibility, and others. However, there is a notable scarcity of studies focused on theoretical considerations regarding the interconnectedness of functional organization within residential spaces and the positioning of entrances. Researchers such as Mate Bajlon, Grozdan Knežević, Milica Živković, Goran Jovanović, Mihailo Čanak, Vladimir Lojanica, Dušan Ilić, and others have made significant contributions in this area, shedding light on the crucial relationship between functional layout and entrance placement.[66]

Mate Bajlon introduces three common concepts of apartment organization in his research, which he has termed as the "X," "Y," and "Z" grouping methods.[67]

63 Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*, 221.

64 Amorim, "The Sector's Paradigm: Understanding Modern Functionalism and its Effects in Configuring Domestic Space."

65 Kray, et al., "Transitional Spaces: Between Indoor and Outdoor Spaces."

66 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*; Bajlon, *Upotrebna vrednost stana*; Knežević, *Višestambene zgrade*; Živković and Jovanović. "A Method for Evaluating the Degree of Housing Unit Flexibility in Multi-Family Housing,"; Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*; Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*; Ilić, *Projektovanje stambenih zgrada 1: Organizacija stana*; etc.

67 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*; Bajlon, *Upotrebna vrednost stana*.

(Figure 15) By analyzing the positions and interdependencies of basic functional units within an apartment—such as common spaces, individual spaces, and households—Bajlon considers various entrance positions within the apartment. However, his research does not delve into the context and motives that led to the emergence of a single entrance rather than multiple entrances.

Grozdan Knežević, like Bajlon, investigates the entrance position and its relationship with the functional groups of an apartment, focusing particularly on central and corner positions of the entrance. Knežević's analyses underscore that while the central entrance position is more common in practice, the corner position can also be effectively organized through the application of extended circulation areas and a diversified apartment layout.[68] Milica Živković and Goran Jovanović point out the significance of central and peripheral entrance positions within an apartment, emphasizing spatial organization and flexibility. They consider the central entrance position as optimal because it allows for the shortest possible connections between all parts of the apartment.[69] In Mihailo Čanak's study on the functional concept and utility value of apartments, he evaluates various ways to establish connections within an apartment. Čanak explores linking the entrance zone with key areas such as the living room, dining area, kitchen, bedroom, bathroom, or toilet, which are common relationships in contemporary design practice.[70] According to Čanak, optimal relationships are achieved by linking the entrance with the living room (as an extended or integral circulation area), the dining area (similarly extended or integral), the kitchen, the toilet, and the bedroom (via a vestibule).

Drawing from Mate Bajlon's theoretical perspectives on residential space organization[71], it is notable that he discusses three common concepts of apartment organization termed as the "X," "Y," and "Z" grouping methods. In his research, Bajlon abstracts the concept into primary components for easier understanding and schematic representation, equating "common spaces" with the living room, "household" with the kitchen, and "individual spaces" with sleeping and hygiene. By analyzing numerous examples that illustrate his claims, it can be noted that in Bajlon's research, "common spaces" encompass not only the living room but also open areas like terraces or balconies, and sometimes the dining room if it is an extension of the living room (referred to as the "family table"). "Household" includes the kitchen along with the dining room if it is an extension of the kitchen, a pantry, and sometimes a toilet. "Individual spaces" refer to the bedroom(s) with a bathroom, vestibule, and occasionally a toilet. While Bajlon's analysis primarily focuses on the arrangement of basic functional units concerning one entrance position, it does not delve into all possible approaches or the reciprocal impact on functional organization. However, his approach provides a foundational understanding, theoretically allowing for the derivation of twelve characteristic entrance positions in an apartment, as presented in schematic form. (Figure 16)

68 Knežević, *Višestambene zgrade*.

69 Živković and Jovanović. "A Method for Evaluating the Degree of Housing Unit Flexibility in Multi-Family Housing."

70 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

71 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*; Bajlon, *Upotrebna vrednost stana*.

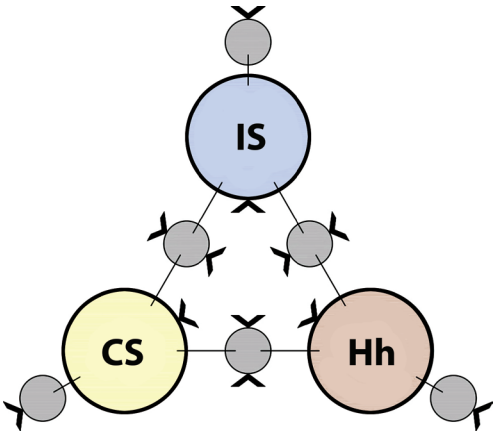


Figure 16 Schematic representation of the basic entrance positions in the apartment (IS - individual spaces, CS - common spaces, Hh - household) (Source: Author's drawing) (left)

Excluding the subvariants of "external" and "internal" entrances in the apartment[72] from further analysis due to its complexity and in line with the presented scheme, the following typology can be derived: (Figure 17)

1) Indirect entrance between communal spaces and householding,
2) Indirect entrance between communal and individual spaces,
3) Indirect entrance between individual spaces and householding,
4) Direct or indirect entrance through communal spaces,
5) Direct or indirect entrance through householding,
6) Direct or indirect entrance through individual spaces.

It is important to note that not all presented entrance positions hold equal importance in the functional organization of an apartment, nor can they offer equally effective solutions. Depending on their significance, purpose, position, or mode of access, entrances can be classified as follows:

1) According to significance (or frequency) - primary (main) entrance, which is most commonly used, and secondary (auxiliary) entrance, which is used occasionally;
2) According to position - "external" entrance, accessed from the external perimeter of the apartment (horizontally), and "internal" entrance, accessed through the central communication core such as an elevator or staircase (vertically);
3) According to mode of access - direct entrance, leading straight into one of the primary residential spaces, and indirect entrance, accessed through a "connecting" space like a vestibule, anteroom, hallway, loggia, terrace, balcony, etc;
4) According to purpose - economic, service, official, fire escape, etc.

Figure 17 Typology of basic concepts of apartment organization in relation to entrance position (IS - individual spaces, CS - communal spaces, Hh - householding) (Source: Author's drawing) (right)

72 The concept of "external" entry into an apartment refers to access through the outer perimeter (considered horizontally), while "internal" entry signifies access through the center of the apartment from the communication core (staircase or elevator) and is mainly found in large apartments that encompass a core.

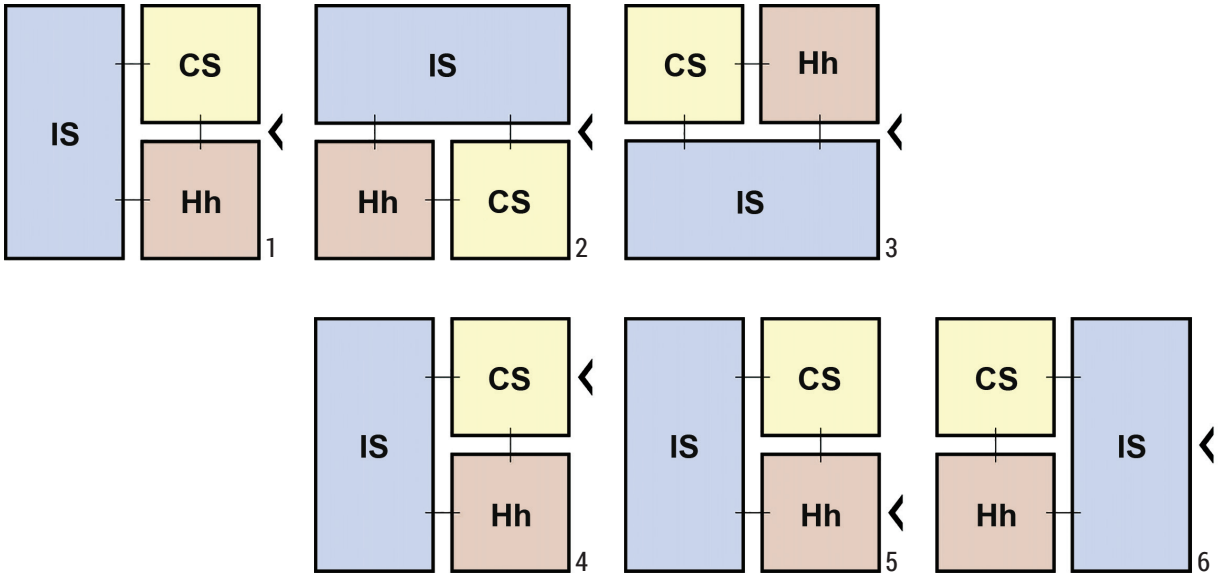
4.1.1.1. *Entrance between common spaces and household*

In this type of apartment organization, the entry direction creates a division between direct access to communal spaces and the household area. The entrance position allows quick access to the living zone via the entry area, easing the process of bringing in groceries. However, it positions the individual zone of the apartment farther from the entrance, which can sometimes hinder proper isolation and openness toward the entry area, thus compromising the intimacy of living. The intersection of the entry direction with the connection between communal spaces and the household may disrupt the smooth flow of communication within the apartment. This entry position primarily corresponds to the main entrance but can also serve as one of the secondary entrances, such as a service entrance or staff entrance, given its proximity to the household areas. In cases of residential-commercial apartments, where a workspace like an office, library, or study is situated within the communal spaces, this entry layout may also accommodate a business entrance.

4.1.1.2. *Entrance between communal and individual spaces*

In this apartment layout, the entry direction serves to delineate a direct connection between common and individual spaces. The entrance position allows swift access to both common and individual areas via the entry section. Unlike some other layouts, this entry position maintains a seamless connection between common spaces and the household, although the distance of the household from the entrance and any potential hindered supply can impact activities in the common areas under certain circumstances. Research by Boumov and Zdral highlights this as one of the most favored concepts among architects due to its facilitation of direct access to common spaces, a central positioning of the living room, and minimized internal communication within the apartment.[73] While primarily intended for the main entrance, this layout can also accommodate certain secondary entrances. For instance, it can be suitable as a business entrance in residential-commercial settings where there's a

73 Boumová and Zdráhalová, "The Apartment With the Best Floor Plan Layout: Architects versus Non-architects."



workspace within the common areas. Additionally, in apartments designed for multigenerational living, having an auxiliary entrance/exit can be desirable for the convenience of younger or older generations.

4.1.1.3. Entrance between individual spaces and household

In this type of apartment layout, the orientation of the entryway establishes a clear separation between the household and individual spaces. The entry position maintains an uninterrupted link between communal areas and the household, ensuring swift access to household areas and streamlined supply through the entry area. The close proximity of individual spaces to the entry point enables seamless transitions between daytime and nighttime zones, fostering the required privacy within the apartment. However, the spatial arrangement where communal spaces are distant from the entry zone can sometimes result in intersecting paths between visitors and the private areas designated for family activities. This intersection may disrupt the apartment's life organization, particularly affecting the intimacy of personal spaces within the apartment.[74] is typically designed as the main entrance, but it can also serve as secondary entrances, such as economic or service entrances, especially due to their proximity to household areas. Additionally, in apartments accommodating multiple generations, having an auxiliary entrance/exit can be beneficial for the convenience of younger or third-generation occupants.

4.1.1.4. Entrance through communal spaces

In this type of apartment layout, the entrance position directly or indirectly leads into the communal space zone, often through a connecting space. It is widely acknowledged that an adequate pre-space at the apartment entrance is essential. This pre-space allows for appropriate preparation for visitors or residents before entering the more private areas of the apartment, even if communal spaces are involved. Depending on the apartment's layout and desired ambiance, this pre-space can take the form of a vestibule, staircase, hallway, elevator, or another type of connecting area. Since the access to individual spaces and the household is typically through communal spaces, a "circular connection" is often necessary to establish proper relationships between functional groups.[75] This entry position primarily corresponds to auxiliary entrances, such as business or guest entrances, which are less frequently used and typically lead to communal areas like the living room, office, or library. In these communal spaces, the need for complete privacy is not as critical. However, if the communal spaces primarily designated for family use do not offer sufficient privacy upon entry, there is a risk of potential functional conflicts. This can occur when the entrance setup does not ensure privacy during transitions into these spaces, such as the living room, dining room, or TV room, which are essential areas for family activities and gatherings.

4.1.1.5. Entrance through the household

In this apartment layout, the entry position directly or indirectly accesses the household zone, either through a connecting space or by penetrating directly into it. Considering the household as a non-representative area of the apartment, where guests are usually not welcomed due to different rhythms and maintenance requirements, and privacy concerns, entry through the household is not typically considered an optimal solution for the main entrance to the apartment. In smaller apartments where maximizing natural light and forming a spacious living area are priorities, it may be necessary to position the kitchen near the entrance. However, this placement doesn't usually offer the ideal main entrance experience. Conversely, having an auxiliary entrance through the household, especially in larger apartments or those with service quarters, can enhance the utility value of the apartment. This auxiliary entrance enables seamless activities such as receiving guests and supplies, which can occur simultaneously without disrupting the household's privacy or function.

74 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*.

75 Alfirević and Simonović Alfirević, 'Circular Connection' Concept in Housing Architecture".

4.1.1.6. Entrance through individual spaces

In this apartment layout, the entry position directly or indirectly accesses the zone of individual spaces, either through a connecting space or by penetrating directly into it. Considering that individual spaces necessitate the highest level of privacy and intimacy in the apartment, this entry position is generally not suitable for the main entrance. However, there are specific cases where this entry position can be applied effectively, such as in apartments with a corner entry. In such cases, indirect linking of one of the functional groups with the entrance, usually the individual space groups, along with the use of extended circulation areas or circular connections, can make this entry position acceptable.[76] This entry position into the apartment typically corresponds to one of the auxiliary entrances, especially when aiming for a higher level of autonomy for guest spaces, younger generations, or third generations. According to Grozdan Knežević, it is crucial to avoid "exposing" the intimate zone of the apartment to the entrance, regardless of the apartment's size.[77]

4.1.1.7. Auxiliary entrance

The implementation of an auxiliary entrance/exit is relatively uncommon in practice and is typically reserved for specific circumstances. These situations arise when there is a need to minimize internal communication within the apartment, guarantee privacy and independent use within specific segments of residential space, or offer an alternative option for utilizing and sharing the space.

76 Knežević, *Višestambene zgrade*.

77 Knežević, *Višestambene zgrade*.

Figure 18 Characteristic apartments with an auxiliary entrance to the kitchen: 1) Kanchanjunga tower, Mumbai (Charles Correa Associates, 1970-1983); 2) Ninetree Village, Hangzhou (David Chipperfield Architects, 2008); 3) Rue Franklin Apartments, Paris (Auguste Perret, 1904) (Source: Authors' archive)

Figure 19 Characteristic apartments with an auxiliary service entrance: 1) Apartment building at Carrer del Mestre Nicolau, Barcelona (Francesc Mitjans, 1957-1960); 2) Seida building, Barcelona (Francesc Mitjans, 1955-1962); 3) Banco Urquijo, Barcelona (José Antonio Coderch, 1967) (Source: Authors' archive)

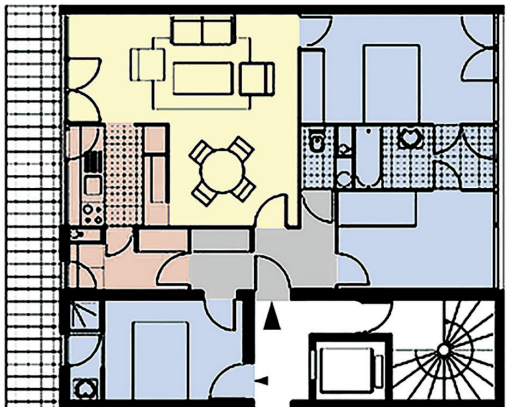
Auxiliary entrance through the kitchen is most commonly applied in situations where it becomes necessary to visually separate the household space as an independent entity within the apartment. This approach allows for more direct access, streamlining household and supply activities. In this type of apartment organization, the dining area is usually separated from the kitchen, either as a separate room or integrated within the living room following an open-plan design. This design choice helps in distancing spaces meant for social gatherings and formal activities from areas that might not be aesthetically pleasing. (Figure 18) The necessity to isolate the kitchen and introduce an additional entrance also arises in situations of frequent and intensive kitchen use, especially in larger households or multi-generational families. Here, the goal is to achieve a certain level of autonomy for the kitchen space due to varied daily routines and specific individual needs within the family. Accessing the apartment through the kitchen can be achieved either indirectly through a connecting space or directly, depending on the layout. Secondary spaces like a pantry, service area, terrace, or balcony often accompany the kitchen area, serving auxiliary roles that complement the functioning of the household.

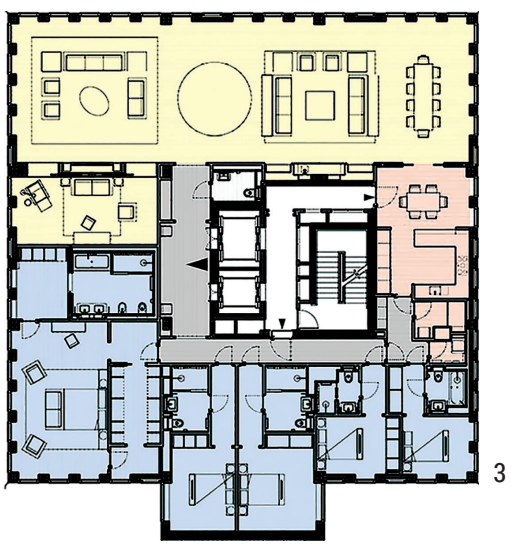
In contrast to examples where an auxiliary entrance to the kitchen caters primarily to family members, apartments designed with a service entrance feature a designated entry intended for staff responsible for maintaining the space and assisting with various household activities. This approach is typical in larger residential spaces that exceed the capacity of a single family to manage, especially in socio-economic contexts where families may hire personnel to oversee household affairs and perform service-related duties.[78] Such apartment layouts often include

78 Brkanić, Stober and Mihić, "A Comparative Analysis of the Spatial Configuration of Apartments Built in Osijek, Croatia, between 1930 and 2015."

a separate area or block designated for the residence of one or more service members, directly linked to the household space. Depending on the apartment's layout, this service block may either be integrated into the individual spaces or kept entirely separate but positioned in close proximity to the common areas of the apartment.[79] Historically, this apartment concept was more prevalent, reflecting easier access to a workforce for household tasks.[80] Today, it is more commonly observed in capitalist societies and affluent households that have the means to employ service personnel. (Figure 19)

It was previously noted that entry into individual spaces may be functional only under appropriate circumstances. In apartments where this type of entry serves as an auxiliary feature within the unit, its existence can significantly enhance functionality by enabling the separation of the individual block and the autonomous functioning of specific activities within it. According to Baylon, this contributes to good apartment organization by facilitating the separation of children's activities and their company from those of parents and their friends.[81] In apartments with a multigenerational user structure,





79 Kubet, *Arhitektonski diskursi promena odnosa funkcije i forme savremenog stana*.; Cunha and Trigueiro, "Towards a Diachronic Panorama of Apartment Living in Brazil."

80 Gürel, "Domestic Arrangements: The Maid's Room in the Ataköy Apartment Blocks, Istanbul, Turkey."; Ducat, *Two for One: The 'Cutting up' Trend – Apartment Modernization in 1930s Manhattan*.; Alfirević i Simonović Alfirević, „'Salonski' stan između dva svetska rata u Srbiji: Preispitivanje opravdanosti korišćenja termina."

81 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*.

Figure 20 Typical apartments with an auxiliary entrance to an individual block: 1) Cité Descartes, Marne-la-Vallée (Yves Lion, 1988-1995); 2) Housing in J. S. Bach street, Barcelona (José Antonio Coderch, 1957); 3) Holland Green, London (OMA & Allies & Morrison, 2016) (Source: Author's archive)

there is a desire for a higher level of intimacy in spatial units. This justifies the presence of an auxiliary entrance that can be used on special occasions when the activities of individual family members need to be separated from others, such as social activities of younger individuals or late-night arrivals. This is especially relevant if there is also a secondary space for gathering within individual areas.[82] (Figure 20)

In the concept of organizing living spaces where residential and business activities are combined, the application of an auxiliary entrance into a workspace can have multiple significances. Depending on the type and intensity of business activities taking place in the apartment, the auxiliary entrance can lead to: 1) a workroom (office) connected to the common areas of the apartment, 2) a work block (office with a pantry kitchen and restroom) designed for business operations and client reception, and 3) an indirectly connected functional unit with a more developed spatial structure (business space with a pantry kitchen, restroom, storage room, etc.). In rare situations, when the business operation is intensive and involves frequent client receptions, it is possible for the main entrance to be primarily designated for clients for representational purposes, while the auxiliary entrance serves the residents. (Figure 21)

82 Ghadir, *An Analysis of Privacy Through Plan Organization in North Cyprus Mass-Housing Apartment Units*.

Figure 21 Typical apartments with an auxiliary entrance to a workspace: 1) Casa N, Murcia (Ad-Hoc, 2015) (Source: Author's archive); 2) Residential building in the Senjak settlement, Osijek (Andrija Mutnjaković, Stanka Polić, Ivan Tomičić, 1968) (Source: Mutnjaković, 1988:61-75); 3) Photographer's Loft, New York (Desai Chia Architecture, 2014) (Source: Author's archive)

In situations involving a multigenerational family community, the concept of a shared living space presents opportunities for the independence of adult children or a young couple, as well as providing independent living for an older individual who requires proximity or occasional care (*in-law suite*).[83] The functional units can be of equal size and structure, or one can be subordinate to the other, but both must have all the essential spaces that two separate apartments would otherwise have. They are often closely connected through the entrance zone, thereby achieving spatial unity, as in the concept of *dual-key apartments*. Depending on the organizational concept, the units may share certain amenities such as common areas or household facilities, which may affect the intimacy between units. When one unit is subordinate to the other, meaning it has a simpler spatial structure, the minimum rooms it needs to have are a bedroom and a bathroom, sometimes including a kitchen. According to Baylon, a solution with two interconnected units on the same floor, which can be expanded or reduced by adding or subtracting one of the rooms, can be considered one of the optimal solutions in cases where the number of family members increases or decreases.[84] (Figure 22) In residential spaces that share certain amenities (shared apartment), such as in rental apartments, student housing, or senior living, there may be separate entrances to individual rooms with bathrooms, while the kitchen, living room, or workspace are shared.

83 Borsi, "Hans Scharoun's 'Dwelling Cells' and the Autonomy of Architecture."

84 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*.

Figure 22 Typical apartments with the possibility of sharing: 1) Siemensstadt, Berlin (Hans Scharoun, 1958) (Source: Borsi, "Hans Scharoun's 'Dwelling Cells' and the Autonomy of Architecture," 1116); 2) "Plus-Minus" Apartment (Source: Bajlon, Stanovanje: Tema 1 – Organizacija stana, 51); 3) Residential Building in Pariska Street 14, Belgrade (Mirko Jovanović, 1956) (Source: Anđelković, „Zgrada u Pariskoj 14," 105)

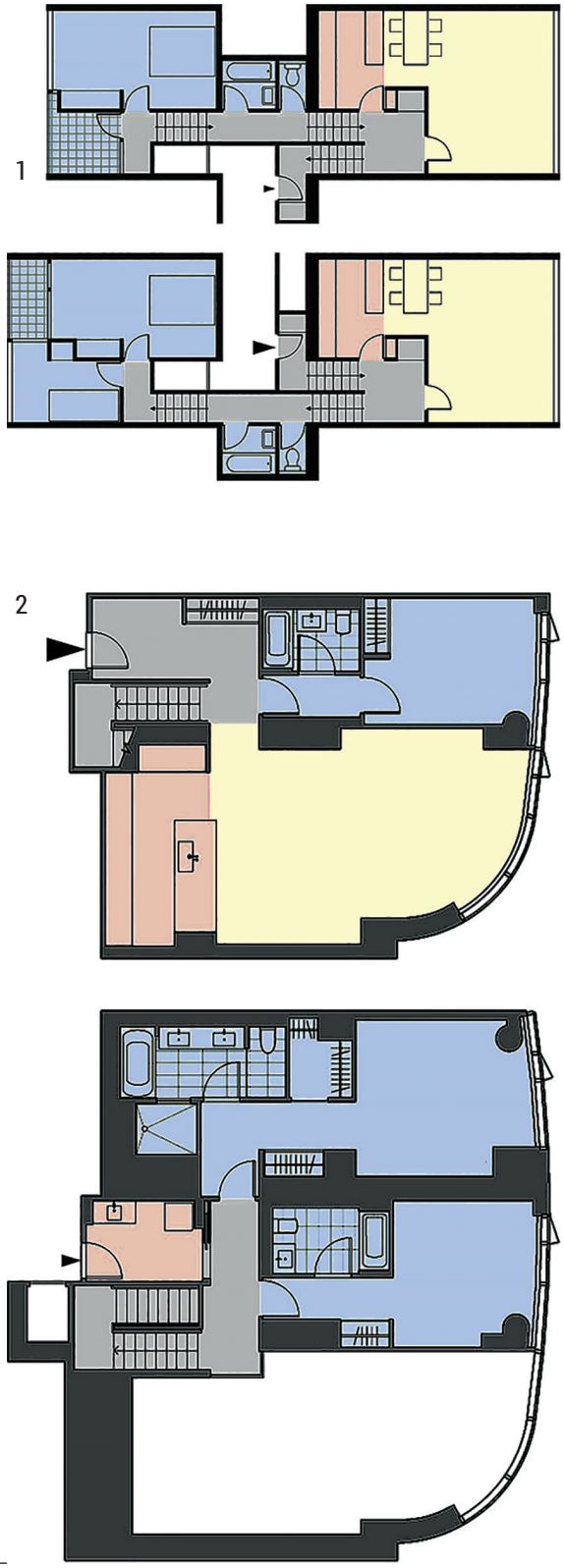


Figure 23 Typical apartments with auxiliary entrances on the second level: 1) Corringham building, London (Kenneth Frampton, 1960); 2) 50 West, New York (Helmut Jahn, 2018) (Source: Authors' archive)

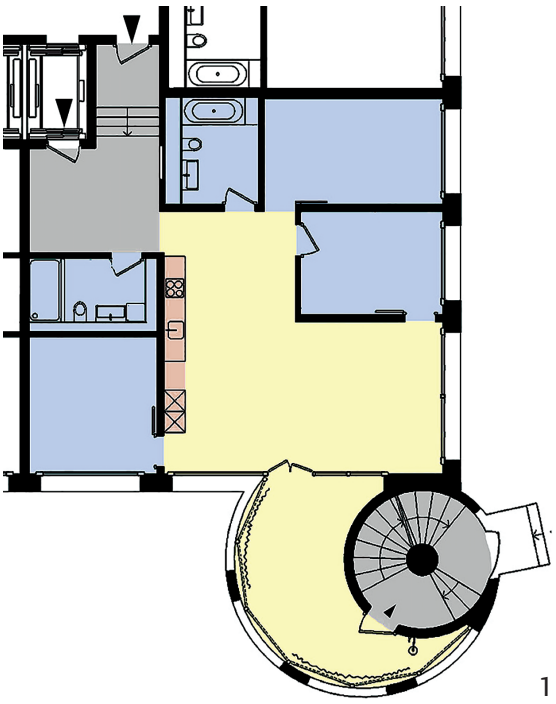
In apartments such as duplexes, triplexes, or maisonette apartments that span two or more levels, secondary entrances are quite common, as their use shortens the path from the entrance to distant rooms. In most examples, residential functions are devided by levels into day and night areas, with the main entrance providing access to common areas, while the auxiliary entrance leads to individual spaces and sometimes to the service area. The importance of separating entrances in this type of apartment organization is evident in the easy distinction of zones and the achievement of a higher level of individuality within the apartment. (Figure 23)

In buildings with multiple floors, alongside the main entrance accessed from common areas or directly from the elevator into the residential space, there is often an auxiliary entrance/exit through the fire escape staircase, which is typically used only during rare situations like evacuation. While the role of such an entrance is primarily peripheral in the everyday conduct of residential activities, its more substantial utilization can diminish or nullify the need for internal circulation zones within the apartment (such as hallways, corridors, or a foyer). (Figure 24)

4.1.2. Arrangement of technical block

The constitutive motive of the technical block or installation core arises from the aim to consolidate and optimize installations within a space, often leading to practices such as connecting bathrooms and toilets, bathrooms and kitchens, toilets and kitchens, or integrating all three spaces together. Within a residential unit, the technical block can be positioned in several

Figure 24 Typical apartments with an auxiliary fire exit: 1) Zellwegerpark Apartment Building, Uster (Herzog & de Meuron, 2015); 2) Tides IV, Charleston (LS3P, 2015) (Source: Authors' archive)



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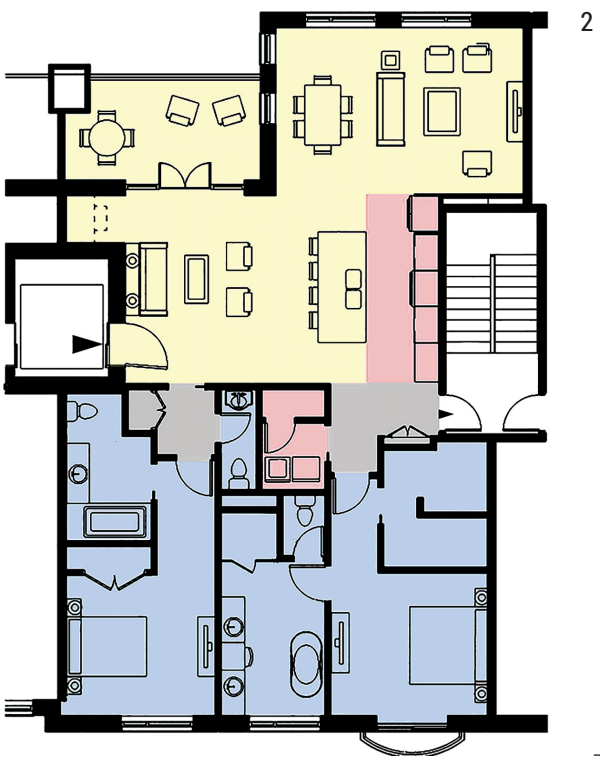

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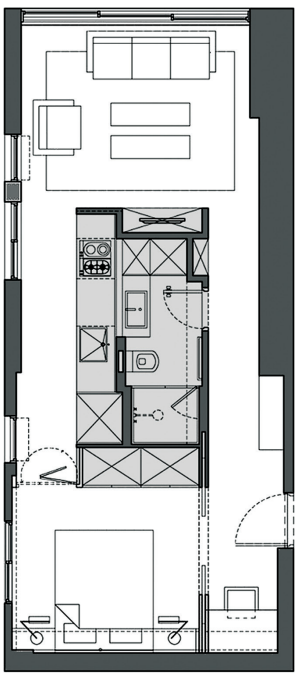
ways: 1) centrally, as a standalone entity; 2) centrally, adjacent to one or more walls within the residential space; 3) positioned against one of the boundary walls, facing the neighboring residential space.[85] When the technical block is in the central zone of the residential space, it can be accessed from all sides. This approach may lead to a circular connection in the form of internal communication, creating continuous or periodic links among the spaces around the core as a whole.[86] In cases where the technical block is situated adjacent to a boundary wall facing the neighboring apartment, the remaining part of the residential space is organized based on other considerations such as function differentiation, flexibility, and similar factors.

The inherent concept described above finds practical expression in various architectural designs. For instance, in the case of the 40 sqm Refurbishment (Tel Aviv, Sfaro Architects, 2011), the connection of the kitchen and bathroom within the technical block allows for a circular connection facilitated by periodically opening sliding doors. This design strategy contributes to a sense of spaciousness within the compact residential space. Similarly, the Abstract House (Hiroshima, Shinichi Ogawa, 2002) features a technical block positioned centrally, primarily serving to delineate the living area from the sleeping quarters due to its linear proportion and layout. However, the design also hints at the potential for establishing a circular connection within the space. A more intricate application of this motive is evident in Villa Norrköping (Sweden, Sverre Fehn, 1964). Here, all

85 Kubet, *Arhitektonski diskursi promena odnosa funkcije i forme savremenog stana.*

86 Živković and Jovanović, "A Method for Evaluating the Degree of Housing Unit Flexibility in Multi-Family Housing."

Figure 25 Motive of the technical block: 1) 40 sqm Refurbishment, Tel Aviv, Sfaro Architects, 2011; 2) Asunto-Oy Hiiralankaari, Espoo, Finland (Erkki Kairamo, 1982-1983) (Source: Authors' archive)



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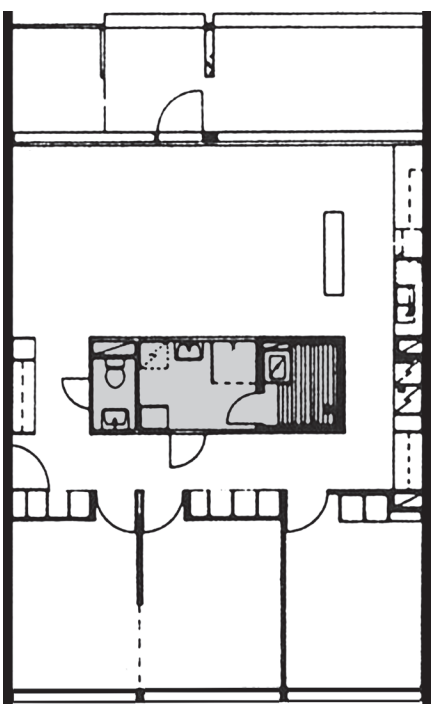

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auxiliary facilities such as the toilet, bathroom, kitchen, and pantry are integrated into the central area of the house. This arrangement contrasts with the peripheral zone designated for residential spaces, showcasing a clear embodiment of the "space within space" concept.[87] (Figure 25)

4.1.3. Arrangement of Space within Space

In architectural theory and practice, four predominant viewpoints are often used to interpret the relationship of space within space: 1) Architectural object in open space; 2) Open space within urban space; 3) Open space within an architectural object; 4) Independent functional block or room within an open-plan space. (Figure 26)

The first and most widely accepted interpretation (Figure 26.1) posits that every architectural object exists within a specific spatial context. This perspective views space within an architectural object in relation to the surrounding urban, rural, or natural environment. Depending on the degree of openness of the object to its surroundings, its connection to the external environment varies.[88] The second interpretation contrasts with the first and pertains to urban environments (Figure 26.2) Here, "interior" space refers to open areas like squares and plazas, delineated by the facades of nearby buildings.[89] From the third perspective (Figure 26.3), "interior" space typically denotes atriums, courtyards, or skylights, while the surrounding space is integrated into the physical structure of the object containing these features.[90] These three interpretations reflect traditional viewpoints used to understand the relationship between different spatial categories until the advent of modern open-plan concepts. Contemporary architectural examples often integrate interior spaces, represented

87 Alfirević i Simonović Alfirević, "Interpretations of Space Within Space Concept in Contemporary Open-Plan Architecture."

88 Brolin, *Arhitektura u kontekstu*.

89 Krier, *Urban Space*.

90 Rapoport, "The Nature of the Courtyard House: A Conceptual Analysis."

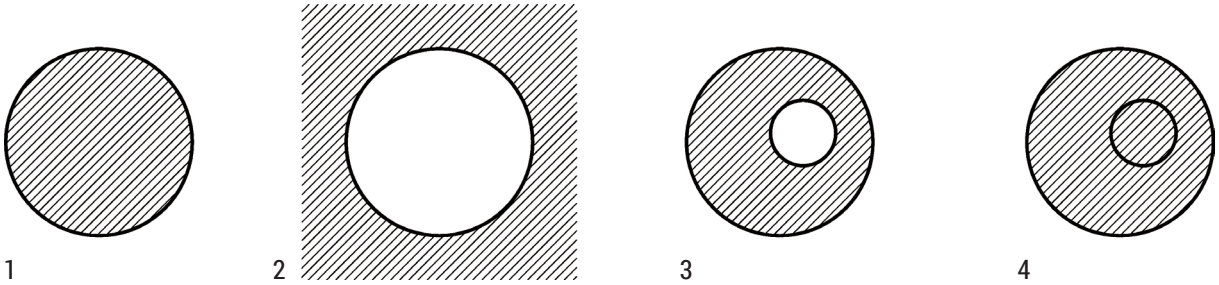


Figure 26 Theoretical interpretations of the concept of space in space (Source: Authors' drawing)

as room clusters, within a larger all-in-one space (Figure 26.4). The differentiation of interior spaces in practice can involve various criteria such as size, shape, materials, color, texture, illumination levels, and more.[91]

The concept of space within space has historical roots dating back centuries, evidenced by early circular megalithic complexes like Stonehenge in the United Kingdom or traditional atrium house designs in the Near East.[92] The first notable example that marked architects' interest in the concept of space within space in residential architecture is the Farnsworth House in Plano, USA, from 1951, designed by architect Ludwig Mies van der Rohe. The Farnsworth House represented a departure from rigid spatial divisions, embracing an open plan structure without fixed partitions. Residential functions were implied through furniture arrangement rather than strict spatial boundaries, creating an open connection to the surrounding forest and river. While the initial design proposed flexible segmentation with curtains into three units, this idea was ultimately not realized in the final construction. This innovative approach of *flowing space* and *open plan*, previously applied to projects like the German Pavilion in Barcelona in 1929, Villa Tugendhat in Brno in 1930, and the Lake Shore Drive Apartments in Chicago in 1951, found expression in the Farnsworth House. A distinctive feature was the grouping of the bathroom and technical space into a single cubic "island" within the open space of the house, showcasing the fusion of functional elements within a unified spatial concept.[93] The design philosophy of the Farnsworth House and similar projects influenced a generation of architects, including the SANAA group, Sou Fujimoto, Shinichi Ogawa, and others, who continued to explore the creative possibilities of the concept. (Figure 27)

The Glass House in New Canaan, constructed in 1949 by architect Philip Johnson, occupies a prominent place on the architect's family estate and is fully integrated with its natural surroundings. The primary driving force behind the design of this structure was its immediate environment, compelling Johnson to consolidate nearly all functions within a single, glass-enclosed rectangular space. Notably, the only exceptions were the bathroom and fireplace, which were ingeniously integrated into a freestanding brick cylinder. Johnson drew inspiration for combining the fireplace and bathroom and highlighting their presence within the space from the prairie houses designed by Frank Lloyd Wright.[94] Similar to the Farnsworth House, the Glass House was not intended for prolonged stays. Instead, it served as a guest reception area within Johnson's estate, complementing his

91 Alfirević i Simonović Alfirević, "Interpretations of Space Within Space Concept in Contemporary Open-Plan Architecture."

92 Rapoport, "The Nature of the Courtyard House: A Conceptual Analysis."

93 Ransoo, "The Tectonically Defining Space of Mies van der Rohe."; Mielnik, "Contemporary Minimalistic Tendencies in Architecture of Single-Family Houses III."

94 Klein, "History, Autobiography, and Interpretation: The Challenge of Philip Johnson's Glass House."

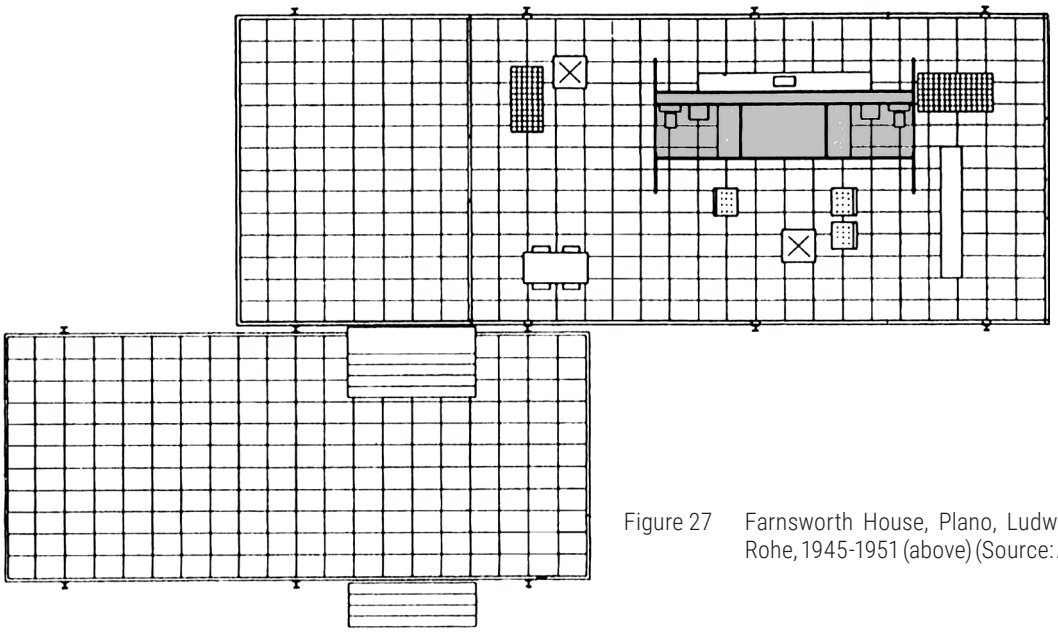
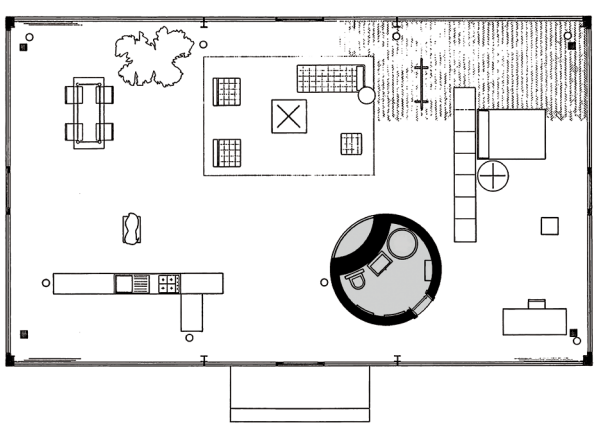


Figure 27 Farnsworth House, Plano, Ludwig Mies van der Rohe, 1945-1951 (above) (Source: Authors' archive)

residence in the so-called Brick House. This intentional separation of functions reflects Johnson's nuanced approach to architectural design, balancing functionality with environmental integration and spatial aesthetics. (Figure 28)

In his family residence in Orinda from 1962 (Figure 29) Charles Moore employed a comparable concept. He emphasized two areas within the interior by incorporating skylight niches, drawing inspiration from the oculus in the Pantheon's dome in Rome. Additionally, he strategically positioned columns at the corners of the skylight cubes, intending to create dynamic shifts in lighting throughout the space.[95] Through the 'oculus' above the larger volume, he illuminated the living room area, while within the smaller volume, he positioned a jacuzzi with a shower, which was sunken into the floor zone and could be visually separated by drawing a curtain as needed.[96] Moore's application of the space-within-space theme is characterized by a more subtle hinting at internal spaces,

Figure 28 Glass House, New Canaan, USA, Philip Johnson, 1949 (below) (Source: Authors' archive)



95 Keim, *You Have to Pay for the Public Life: Selected Essays of Charles W Moore*, XIV-XV; LaVine, *Mechanics and Meaning in Architecture*.

96 Keim, *You Have to Pay for the Public Life: Selected Essays of Charles W Moore*.

unlike Mies van der Rohe and Johnson, who firmly defined their boundaries. In the case of another family house in New Haven from 1967 (Figure 30), Moore played with the excavation of several spatial 'wells,' visually uniting the basement, ground floor, and upper floor of the house, paying more attention to the attractiveness of the internal space than to functionality.[97] His approach adds a layer of aesthetic complexity and spatial intrigue, highlighting the interplay between light, form, and function within the architectural framework.

Architect Sverre Fehn advanced previous concepts with his execution of a Nordic villa in Norrköping, Sweden, in 1964. He positioned a central core containing the kitchen and sanitary spaces, around which living, dining, and sleeping rooms are interconnected via a circular connection. Unlike prior solutions tailored for specific clients, Fehn's house was conceived within a competition framework for Nordic houses under the theme 'House of the Future,' envisioned for an unknown client, i.e., an imaginary family of four.[98] The corners of the structure are glazed, opening up to the surroundings, while the internal spatial arrangement is adaptable, featuring sliding partitions that can divide the all-in-one space

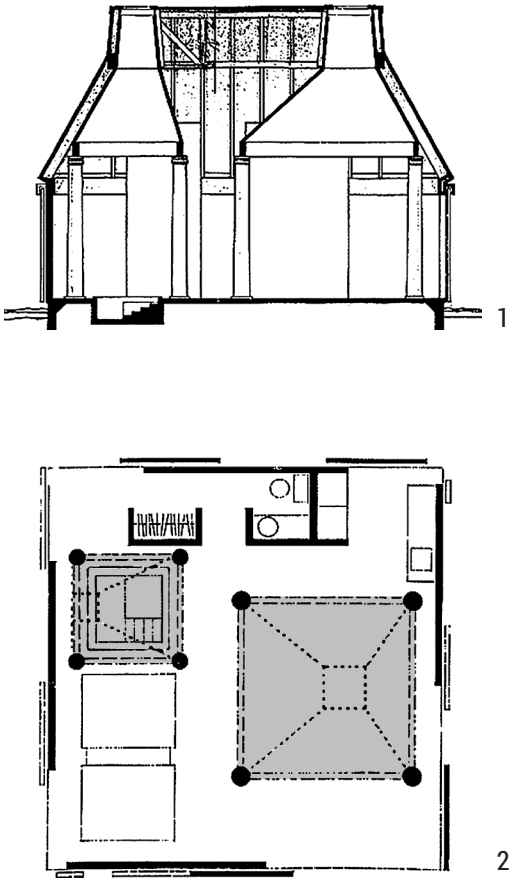


Figure 29 Moore House, Orinda, Charles Moore, 1962 (1) section, (2) plan (above) (Source: Authors' archive)

97 Keim, *You Have to Pay for the Public Life: Selected Essays of Charles W Moore*.

98 Papkovskaia, "Sverre Fehn's Norrkoping Villa (1963–4)," 5; Zrnikova, *Arkitekt Sverre Fehn: Intuisjon, refleksjon, konstruksjon*.

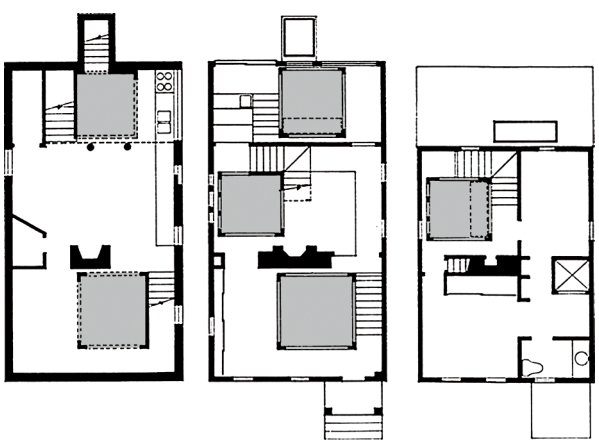


Figure 30 Moore House, New Haven, Charles Moore, 1967 (left) (Source: Authors' archive)

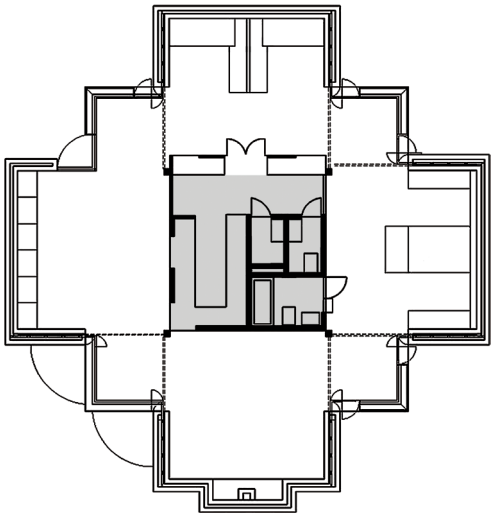
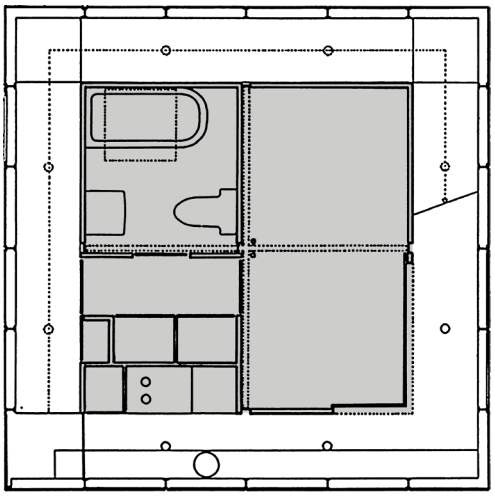


Figure 31 Villa Norrköping, Sweden, Sverre Fehn, 1964 (above) (Source: Authors' archive)

Figure 32 Cubist House, Yamaguchi, Shinichi Ogawa, 1990 (below) (Source: Authors' archive)



into smaller units as required, thus achieving varying degrees of openness within the apartment.[99] The spatial layout highlights the positions of water symbols (kitchen and sanitary spaces) and fire (fireplace), strategically placed along one of the main axes of the cruciform base of the structure. Fehn's concept was to avoid direct entry of light into the building, creating a design that is not entirely open to its surroundings. Instead, light intersects the space diagonally, creating zones of brightness and darkness within the apartment and accentuating their functional diversity. This approach adds a layer of dynamism and adaptability to the spatial experience, contributing to a unique living environment that harmonizes with its natural context.[100] (Figure 31)

The Cubist House in Yamaguchi, designed by Shinichi Ogawa in 1990, applies a similar organizational principle, where the building's outer shell is partly separated from its core. Ogawa's concept contrasts abstract sculpture with the traditional Japanese house environment, resulting in a unique architectural expression.[101] Traditional elements like columns, walls, and roofs, commonly found in the surroundings, are transformed into points, lines, and surfaces, reducing their material presence. The glass cuboid envelope, with its 6-meter-high sides, nearly occupies the entire plot. Ramps within the space between the envelope and the core twist and rise, connecting different levels seamlessly. The top level features a workspace offering panoramic views of the surroundings, while centrally located rooms showcase a cubic structure emphasized by light strips that Ogawa describes as „large furniture."[102] (Figure 32)

Following the example of the Farnsworth House, architect Shinichi Ogawa designed the Abstract House in Onomichi, Okinawa in 2002, based on the concept of space within space. Unlike Mies's structure, which is entirely open to the surroundings, the Abstract House is of an introverted

99 Čanak, „Otvoren ili zatvoren stan."

100 Papkovskaia, "Sverre Fehn's Norrkoping Villa (1963–4)."

101 Yamaguchi. "Shinichi Ogawa: Roaming into Immanence."

102 Mielnik, "Contemporary Minimalistic Tendencies in Architecture of Single-Family Houses III."

type. It consists of living space, a garden in front and behind it, enclosed by high walls on the sides and frosted glass on the other two opposing sides. Most rooms are interconnected within differentiated living and sleeping zones. The central position in the house is occupied by a block housing auxiliary spaces, akin to the Farnsworth House, where closets, a bathroom, and a dressing room are combined. A certain inconsistency in the design is the position of the kitchen, formed as an island in the open space rather than integrated into the enclosed block. The position, dimension, and orientation of the central block clearly indicate the architect's intention to visually connect the opposing gardens with the living spaces in the center of the house while enclosing the house space from the dynamic environment on the other side.[103] (Figure 33)

Prompted by earlier discussions on the concept of space within space, the Flower House project in Lens, France, by the SANAA group in 2005 represents a notable shift towards utilizing more fluid forms in architecture.[104] The Flower House embodies the designers' vision of a residential space seamlessly integrated with its natural surroundings, devoid of physical barriers like columns or walls. Instead, load-bearing functions are achieved through undulating glass envelopes both on the perimeter and within the atrium. This design philosophy, often termed "dematerialization", draws inspiration from Mies van der Rohe's 1922 project for a skyscraper on Friedrichstrasse in Berlin.[105] The Flower House features atrium spaces, clusters of sanitary facilities, and staircases arranged freely within its flowing spatial structure. These elements serve not only to delineate the boundaries of the fluid spaces in relation to the

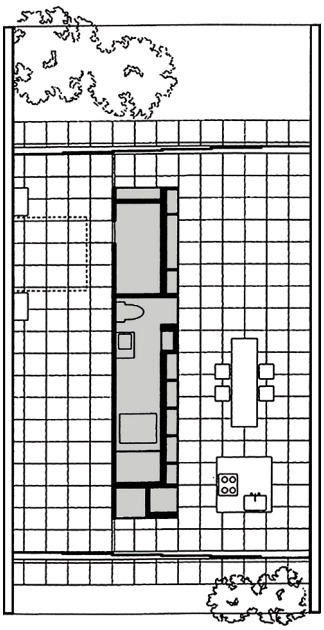
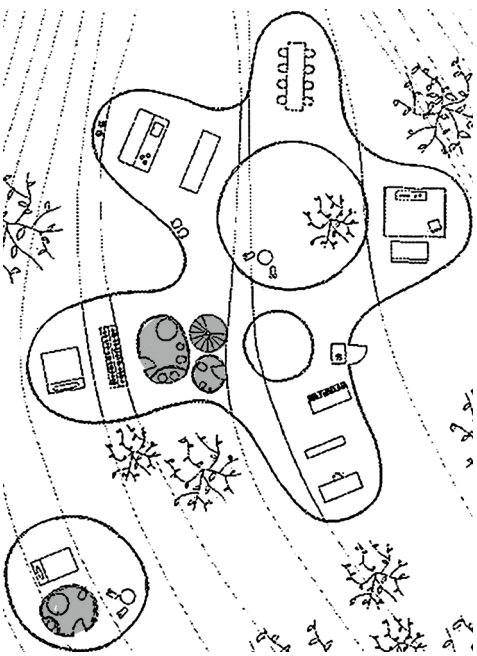


Figure 33 Abstract house, Onomichi, Shinichi Ogawa, 2002 (above) (Source: Authors' archive)

Figure 34 Flower House, Lens, SANAA, 2005 (below) (Source: Authors' archive)



103 Iwatate and Mehta, *Japan Houses: Ideas for the 21st Century*, 26–31; Mielnik, "Contemporary Minimalistic Tendencies in Architecture of Single-Family Houses IV."

104 Levene and Cecilia, „Kazuyo Sejima + Ryue Nishizawa 1995–2000."

105 Gonzalez LLavona, "Desaparición y desvirtuación de la estructura en la obra de Sejima-SANAA / Structure Disappearance and Transformation in Sejima-SANAA´s Work."

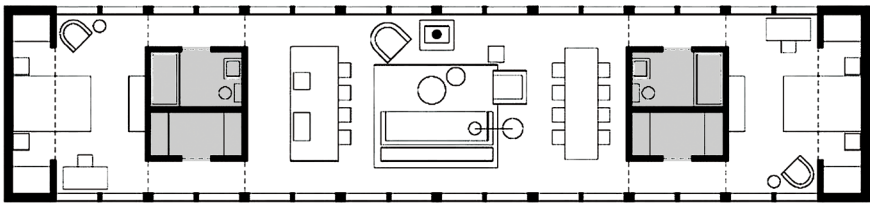


Figure 35 Sixteen Doors Home, Hillsdale, Incorporated Architecture & Design, 2005 (Source: Authors' archive)

undulating outer facade and circular atrium openings but also to minimize spans between inter-floor ceilings. (Figure 34)

The Sixteen Doors House, designed in 2005 by the architectural studio Incorporated Architecture & Design, draws inspiration from the elongated shapes of barn structures in Hillsdale, USA, and the 'Minka' farmhouses in Japan. The house's design is also influenced by the desire to maximize its connection with the surrounding forest on two of its longer sides.[106] Internally, the house is organized to clearly delineate between daytime and nighttime zones, with two blocks housing bathrooms and wardrobes. The emphasis on implementing the space within space concept led to the creation of doubled corridors around the sanitary blocks. While this design choice adds visual interest, it introduces a functional inconsistency. (Figure 35)

In his endeavors to rediscover the fundamental essence of architecture, Sou Fujimoto embarked on a journey that led him to explore the essence of nature in his designs. Following his initial forays with concepts such as the tree and cave in projects like the Primitive Future House and the Wooden House in Kumamoto, Fujimoto delved deeper into the integration of various residential functions in House N in Oita in 2008. Rather than employing solid walls for separation, he introduced 'semi-permeable filters' in the form of partitions punctuated with large openings, fostering a dynamic interaction between the interior and exterior spaces.[107] The architectural composition of House N revolves around three perforated 'boxes.' The largest box envelops the entire site, delineating the boundary towards the public space, while two smaller boxes, nested within each other, constitute the core of the house. Fujimoto's design embraces a layered 'canopy-like' structure, inviting users to explore new spatial possibilities within the dwelling.[108] One of Fujimoto's distinctive approaches is the intertwining of external and internal spaces, reflecting his belief that the ideal architectural experience blurs the distinction between enclosed and open spaces. He likens this interplay to the intricate structure of a nest, where one feels simultaneously sheltered yet connected to the surrounding environment.[109] (Figure 36)

The Light Walls House, designed by mA-style Architects in Toyokawa in 2013, embodies an introspective architectural approach due to its positioning between neighboring buildings on two sides. This unique context led the architects to prioritize the admission of light primarily through lanterns in the roof, thus orchestrating a controlled and immersive lighting experience within the house. By channeling light in this manner, the interior spaces achieve a heightened spatial richness. The design strategy also involves the strategic placement of rooms

106 Smith Macisaac, "Pure and Simple."

107 Siddiqui, *Immaterial Architecture: Composing Space From Sound*.

108 Siddiqui, *Immaterial Architecture: Composing Space From Sound*.

109 Vasilski, "Minimalism in Architecture: Abstract Conceptualization of Architecture."

such as the bathroom, storeroom, and bedrooms, which do not necessitate natural daylight, throughout the space. These rooms vary in height, contributing to an abstract yet harmonious composition of white volumes within the interior. This arrangement not only optimizes the diffusion of light but also creates an intriguing interplay of volumes, enhancing the overall aesthetic appeal. The functional zones along the house's edge, illuminated by direct roof lighting, encompass workspaces and the kitchen block. These areas, juxtaposed against the diffusely lit zones, establish a dynamic contrast within the interior environment. The interior spaces, conceptualized as 'boxes' with a flexible arrangement within the house's layout, evoke a sense of a courtyard or a small square. The white volumes, resembling abstract representations of buildings, invite inhabitants to navigate through the space akin to strolling around a miniature urban landscape, fostering a unique and engaging spatial experience. (Figure 37)

A chronological analysis of the evolution of the concept of space within space, from historical to contemporary examples, highlights the pivotal influence of architect Mies van der Rohe's Farnsworth House in shaping modern interpretations of this concept. Building upon the foundational principles of open plan design established by Frank Lloyd Wright in the Larkin Building in Buffalo in 1906, the Farnsworth House embodies a spatial-functional core within an all-in-one space, contributing significantly to the development of this architectural idea. Depending on the application and purpose of the concept of space within space, distinct design perspectives can be identified:

1) "Spatial organization" of functional units: This perspective emphasizes the clear articulation of distinct functions within the building not only through spatial layout and facades but also by dimensionally and visually emphasizing them within the interior space. Examples include the Cubist House in Yamaguchi by Shinichi Ogawa (1990), the Moore House in Orinda by Charles Moore (1962), among others;

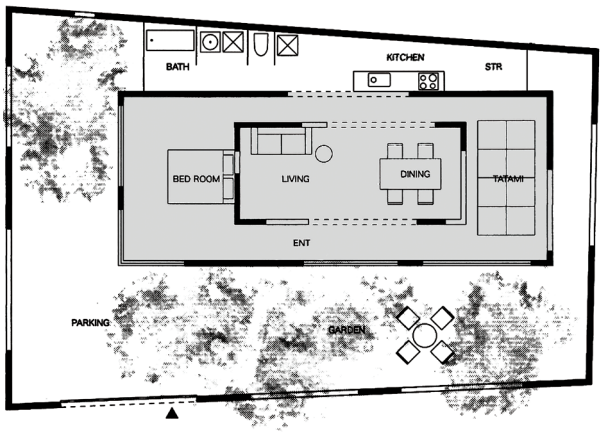
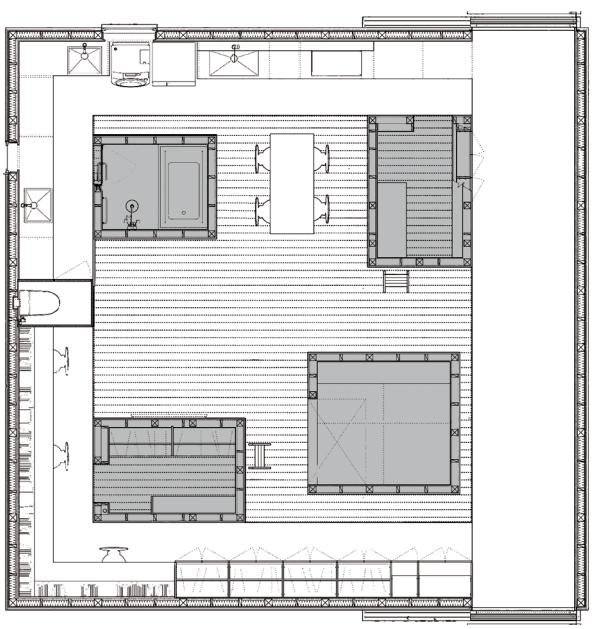


Figure 36 House N, Oita, Sou Fujimoto, 2008 (above) (Source: Authors' archive)

Figure 37 Light Walls House, mA-style Architects, Toyokawa, 2013 (below) (Source: Authors' archive)



2) Formation of a technical block as a constitutive motif: This perspective focuses on grouping related functions like bathrooms, kitchens, toilets, saunas, etc., into a "freestanding" functional-technical block. This approach minimizes the number of installation points and is observed in iconic designs such as the Farnsworth House, Plano, Ludwig Mies van der Rohe, 1951; Glass House, New Canaan, Philip Johnson, 1949; Abstract house, Onomichi, Shinichi Ogawa, 2002; Sixteen Doors Home, Hillsdale, Incorporated Architecture & Design, 2005; Villa Norrköping, Sweden, Sverre Fehn, 1964, and others;

3) Formation of internal cores with a primary structural role: This perspective seeks to remove vertical structural elements from the interior space, enhancing spatial flexibility. Examples include the Flower House in Lens by SANAA (2005) and others;

4) Formation of a perceptual effect: This perspective aims to achieve a specific visual effect through spatial layering and segregation, aligning the form of the object with its thematic essence. Examples include House N, Oita, Sou Fujimoto, 2008; Light Walls House, Toyokawa, mA-style Architects, 2013; Moore House, New Haven, Charles Moore, 1967; and others.

It's worth highlighting that applying the concept of space within space in residential architecture can sometimes result in specific and, at times, extreme conditions of space usage. The desire to establish freestanding cores and eliminate unnecessary barriers for visual impact in spatial organization can occasionally lead to impractical solutions in certain situations.

4.2. Differentiation of functions

Differentiation of functions represents the broadest category of foundational elements in housing design, as it directly addresses fundamental human needs. The incorporation of functional differentiation is primarily motivated by various human needs and the diverse ways in which spaces are utilized. Within a residential complex, spaces can be differentiated based on biological rhythms, leading to the separation of day and night zones, where different usage patterns and intensities are observed throughout the day.[110] In more intricate residential settings with multiple functions, spaces are often differentiated according to the desired level of privacy. This includes divisions into individual and communal areas for family members, designated reception areas for visitors, and service zones for staff.[111] Additionally, spaces may be differentiated based on the ages of occupants, distinguishing areas for children from those intended for parents, among other criteria.[112] In rare instances, where there is a necessity to accommodate three generations within a single residential unit, spaces can be differentiated based on the ages of the occupants, ensuring that each generation has tailored areas that cater to their specific needs and preferences.[113]

Residential space differentiation is employed to address specific human needs within distinct groups or to mitigate functional conflicts and incompatibilities between spaces. Families, as well as individual family members, transition through various developmental stages known as "family cycles," each stage presenting unique housing requirements. These developmental stages can be categorized into four main phases: 1) young married couple, 2) growing family, 3) stable family, and 4) shrinking family.[114] Throughout these stages, there are evolving needs for both individuality and collective experiences among family members, necessitating the differentiation of specific spaces within the residence.

110 Marušić, *Projektovanje 2: Višeporodično stanovanje – Sveska 6, 7.*

111 Cunha and Trigueiro, "Towards a Diachronic Panorama of Apartment Living in Brazil."

112 Bajlon, *Stanovanje: Tema 1 – Organizacija stana.*

113 Montgomery, "The Housing Patterns of Older Families."; Memken, Garber-Dyar and Crull, "Space Planning in Residential Design."

114 Dinić, „Analiza odnosa strukture porodice i organizacije i strukture stana."

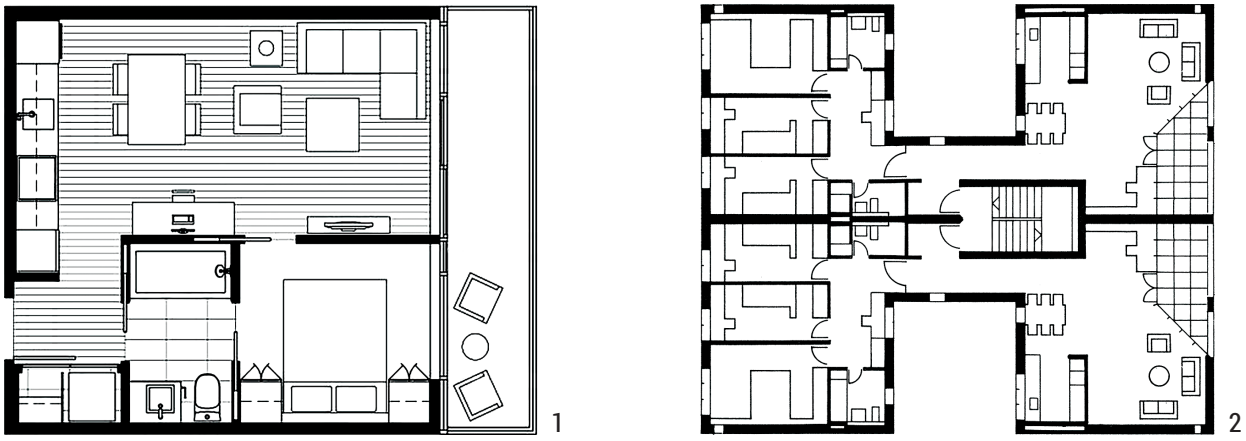


Figure 38 Differentiation of the daytime and nighttime zones: 1) direct connection (MC2 Housing, Vancouver, James KM Cheng Architects, 2018); 2) indirect connection with a single link (Buchgrindel 2, Zurich, Theo Hotz, 1985) (Source: Authors' archive)

4.2.1. Separation according to biological rhythm

Space separation based on biological rhythms is a fundamental aspect across all stages of family development, making it a primary form of space organization. In practical terms, residential spaces are frequently categorized according to users' daily rhythms into daytime and nighttime (intimate) zones, with distinct functionalities for each.[115] The daytime segment usually encompasses an entry space, often with a wardrobe, along with areas such as the living room, dining area, kitchen, pantry, and a toilet. On the other hand, the nighttime zone typically includes bedrooms, one or more bathrooms, a dressing room, and other internal connections and storage spaces.[116]

According to Čanak, the link between the daytime and nighttime segments can be *direct* if the nighttime area operates independently, allowing users to complete all necessary tasks before entering the daytime region typically visited by guests. Alternatively, the connection can be *indirect* (meditated), facilitated by a corridor or dressing area when transitioning between the daytime and nighttime zones. From a functional standpoint, it's deemed optimal to connect the dressing area with the entry space as it enables users to access or exit the private part of the apartment without traversing through the daytime areas. Various methods can be employed to connect the daytime and nighttime areas effectively: 1) via the entry space, 2) through an extended circulation area incorporating the dining space, 3) through the dressing area within the private zone, and also through the dining or living areas in cases of dual connections.[117] In this context, we can identify three primary methods of linking the daytime and nighttime sections:

1) Direct connection,
2) Indirect connection (with a single link), and
3) Indirect (with a dual link).

A characteristic example of direct connection between the daytime and nighttime zones can be found in the MC2 Housing apartments (Vancouver, James KM Cheng Architects, 2018), where the bedroom directly adjoins

115 Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*.

116 Nowakowski, "Ergonomic Shaping of Functional and Spatial Program of Housing."

117 Čanak, *Svi moji stanovi*.

the living space yet maintains its independence due to a direct connection with the bathroom. An example of an indirect connection between the daytime and nighttime segments can be observed in an apartment on Buchgrindel Street in Zurich (Buchgrindel 2, Zurich, Theo Hotz, 1985), where the separation based on biological rhythms is established by dividing the daytime and nighttime zones into two parallel lamellas connected by a single link in the form of a corridor. The principle of a dual connection between the daytime and nighttime areas is applied in the Solar House project in Topola (Studio Alfirević, 2013), where the primary connection is established through the entry area between the living room and one bedroom, while an alternative connection is formed through the dressing area between the daytime zone and the parents' bedroom. (Figure 38)

4.2.2. Separation of children and parents

A crucial aspect of spatial organization is the ability to segregate children's activities from those of parents, especially when both occur simultaneously.[118] In situations where young children and their friends mingle with adults, it's beneficial to maintain a certain proximity between the areas designated for adult conversation and those for children's play. This arrangement allows for occasional supervision and oversight of their activities. However, as children grow into adolescence and seek more privacy, it becomes preferable within residential spaces to establish two distinct gathering areas.[119] This approach is considered optimal, providing separation between children's rooms and the spaces designated for adult gatherings.

Separating children's rooms from the parental bedroom is also desirable due to the potential for intimate relationships between parents and ensuring a more peaceful night's rest for all family members. The unity of the man and woman in the family plays a significant role in the stability of family relationships, primarily stemming from the closeness and understanding between the father and mother, which are then transferred to the children. Therefore, it is important for the parental bedroom to have a degree of autonomy (proximity to the bathroom and wardrobe) and separation from other living spaces. In the early stages of family development (when the family is growing), the child is still small and requires constant supervision, hence the need for the child's bed to be close to the space where the parents spend time.[120] An optimal solution could involve having the child's room closely connected to the parental bedroom, or temporarily placing the child's bed in the parental bedroom. However, the latter is less functional as it may disrupt the harmony and rest of the parents. For stable psycho-physical development, it is necessary for the child to have constant contact with the mother in the early years of life, implying the proximity of the child's bed to the parental bedroom. It's considered essential to separate the child between the ages of three and six when they begin their independent development and need a certain level of privacy in their own room. Milena Dinic identifies three periods of child development concerning the quantity and quality of relationships and unity with parents:[121]

1) Preschool-age child (up to six years old) - has an intense need for unity with parents, as well as with siblings. Initially, this need is predominantly biological, but later it acquires a psycho-social component;

2) School-age child (from starting school to 12 years old) - has a partial and intermittent need for unity with parents. This phase is characterized by a decrease in the intensity of the need for family unity;

118 Bajlon, *Stanovanje: Tema 1 – Organizacija stana;* Ilić, *Stan i porodica: Organizacija i struktura stana u funkciji inteziviranja socijalnih odnosa u porodicama sa decom*.

119 Alfirević and Simonović Alfirević. "Spatial Organization Concepts for Living Spaces With Two Centres."

120 Katanić, „Potrebe dece i njihov uticaj na prostorne i organizacione karakteristike stana."

121 Dinić, „Analiza odnosa strukture porodice i organizacije i strukture stana."

3) Older child (after 12 years old) - has a different need for unity, less with parents and more with friends. There's an emphasized need for children to separate, become independent, have privacy, and individualize.[122]

A characteristic example of separating children's and parents' activities can be found in the Casa CP (Barcelona, Baas Arquitectos, 2009) where the nighttime block physically separates children's bedrooms and bathrooms from the parents' area, equipped with a wardrobe and bathroom, ensuring autonomy for both sections. In the daytime block, alongside the seating area, there's a dedicated space for children's activities. In the Apartment in Šaltinių Street (Vilnius, DO Architects, 2015) a double indirect connection between the nighttime and daytime blocks allows independent use of both parents' and children's spaces. However, maintaining proximity between parents' and children's rooms is crucial for easier supervision when the child is young. In this example, the separation of parents' and children's activities during gatherings is not explicitly achieved in the living area, but it can be facilitated by incorporating the dining table for children's activities. In the design proposal for an apartment in the settlement west of Ivan Ribar Street in Belgrade (Darko Marušić, Milenija Marušić, Đorđe Alfirević, 2011), two distinct nighttime blocks with independent bedrooms are established, ensuring a complete segregation of activities and providing opportunities for rest and privacy for both parents and children. (Figure 39)

122 Katanić, „Potrebe dece i njihov uticaj na prostorne i organizacione karakteristike stana."

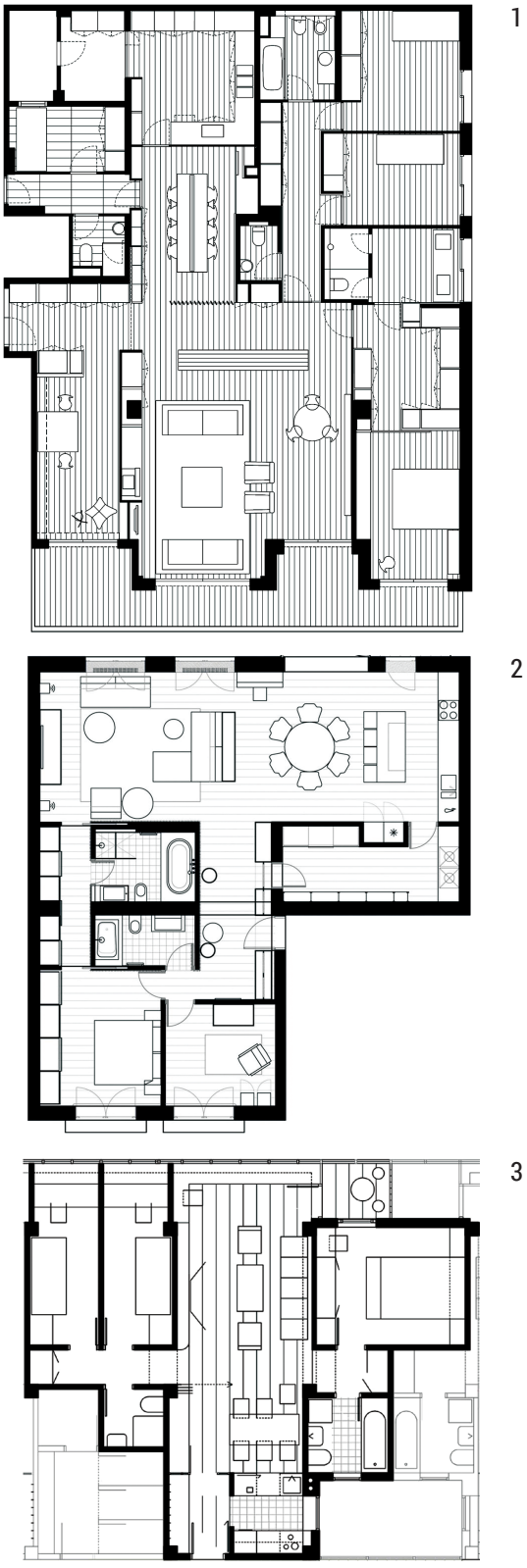
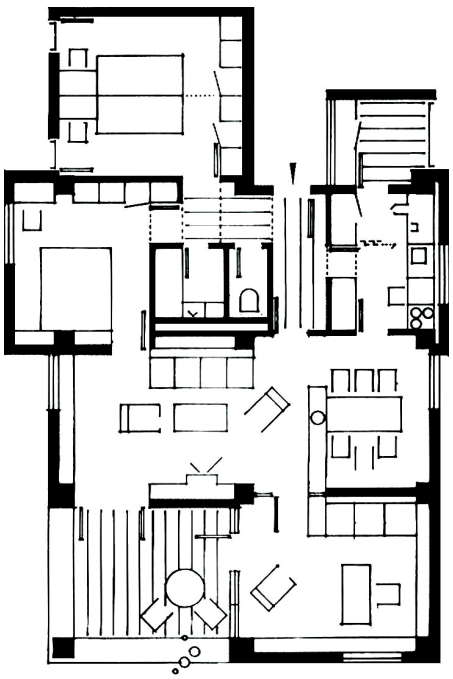


Figure 39 Separation of children's and parents' activities: 1) Casa CP, Barcelona, Baas Arquitectos, 2009; 2) Apartment in Šaltinių Street, Vilnius (DO Architects, 2015); 3) Residential settlement west of Dr. Ivana Ribara Street, Belgrade (Darko Marušić, Milenija Marušić, Đorđe Alfirević, 2011, competition work) (Source: Authors' archives)

4.2.3. Separation of children by gender

The ability to separate children by gender becomes notably significant for their holistic psychophysical development after the age of six. During early childhood, children become increasingly aware of gender distinctions and aspects of their sexuality, underscoring the importance of providing appropriate spatial arrangements for their natural separation.[123] In the developmental phase spanning middle childhood, children typically develop a preference for playing with peers of the same gender. They exhibit a growing curiosity about gender-specific information and biological differences between boys and girls. This period marks a pivotal stage where children begin to explore and understand gender roles and characteristics.[124] It is generally acknowledged that by around the age of seven, children tend to prefer gender-specific play and may benefit from having separate bedroom spaces to accommodate their evolving needs and interests without hindrance.

For families with two or more children, a practical approach may involve initially having a shared playroom and living space for children. Following guidelines for child development, children of different genders are typically recommended to have separate rooms after the age of six. Conversely, children of the same gender can share a room until around the age of 12, after which individual spaces are usually preferred. This transition supports children's evolving need for personal space and privacy. Given these considerations, a two-bedroom setup may not adequately meet the long-term needs of families with two children, irrespective of gender. A more strategic solution involves having a



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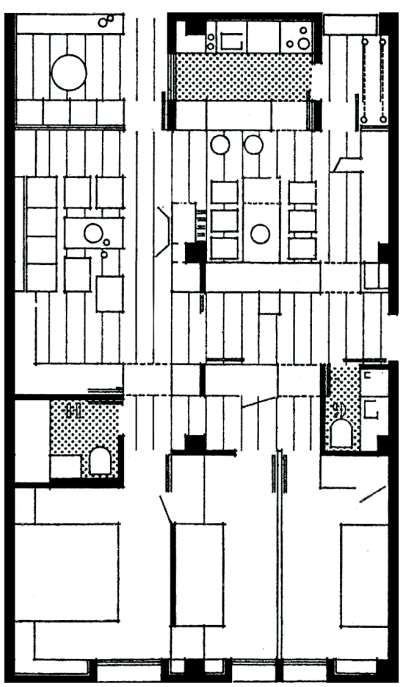

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123 Brković, *Razvojna psihologija*.

124 Baucal, *Standardi za razvoj i učenje dece ranih uzrasta u Srbiji*.

Figure 40 Separation of children by gender: 1) shared dividable room (Blocks 61 and 62, southern part, Belgrade, Darko Marušić, Milenija Marušić, Milan Miodragović, 1978); 2) possibility of connecting children's rooms (Apartment in Cerak, Belgrade (Darko Marušić, Milenija Marušić, Nedeljko Borovnica, 1981) (Source: Authors' archives)

larger shared children's room that can be partitioned into two separate rooms as needed. This arrangement requires careful planning, ensuring that the divided rooms each have at least two windows and two doors to function independently and provide sufficient natural light and access.[125] Implementing such an approach has demonstrated its effectiveness, particularly in mitigating potential jealousy issues among siblings in two-member and larger families. By creating two smaller yet equally sized rooms post-partitioning, this method fosters a sense of fairness and personal space for each child, contributing positively to family dynamics and harmony.

A characteristic example of a shared children's room designed for potential division is found in an apartment in the southern part of Blocks 61 and 62 in New Belgrade (Darko Marušić, Milenija Marušić, Milan Miodragović, 1978). In this layout, the shared room is strategically placed near the entrance within the night block. By incorporating a partition through the middle of the room extending towards the closets, it becomes feasible to create two smaller children's rooms. Similarly, another application of this concept can be observed in an apartment complex situated in the Cerak neighborhood in Belgrade (Darko Marušić, Milenija Marušić, Nedeljko Borovnica, 1981). Here, while the rooms are physically distinct, they offer the flexibility to combine into a larger room when needed, providing versatility based on the family's requirements. (Figure 40)

4.2.4. Separation of older and younger individuals

The term "third generation" typically refers in literature to the inclusion of grandparents in the family dynamics of an extended family (comprising parents and children).[126] Research conducted by Karsten Hank and Isabelle Buber across ten European countries aimed to understand the lifestyles and activities of older adults post-retirement. The study noted that 8% of grandparents live in the same household as their children (sons or daughters) and grandchildren. In Sweden and Denmark, around 20% of grandmothers, more frequently than grandfathers, assume daily caregiving responsibilities for their grandchildren. Conversely, in Greece and Spain, over 40% of grandmothers are actively involved in caring for the children of working parents.[127] Numerous studies underline the significance of older adults' presence within households and their active roles in child-rearing.[128] However, research by Ana Shtifter and her team indicates that in about 10% of cases, family conflicts may arise, potentially leading to marital strain or divorce due to the involvement of partners' parents in the marital relationship.[129] The collective findings suggest that while three-generation households are not uncommon, they are not devoid of challenges. Therefore, it is crucial to acknowledge and consider the dynamics of cohabitation among all household members within the same living space.

The harmonious coexistence of the third generation within a household hinges significantly on the dynamics with the second generation (parents), as the most common source of issues arises from well-intentioned but potentially intrusive involvement by grandparents in parental decisions, all geared towards the welfare of their grandchildren. To mitigate these challenges, it is advisable for the living space to provide older adults with a degree of independence, enabling them to step back during periods of strained relationships or potential conflicts while remaining accessible to maintain their bond with their grandchildren. Creating physical distance for the third generation is also beneficial from the perspective of ensuring the necessary tranquility required for their well-being, achievable through the establishment of a self-contained functional unit comprising a combined room, a mini-kitchen, and a

125 Dinić, „Analiza odnosa strukture porodice i organizacije i strukture stana."

126 Pašalić i Alić, „Obilježja kohezivnosti i kompetentnosti porodičnog sistema u međugeneracijskom djelovanju."

127 Hank and Buber, "Grandparents Caring for Their Grandchildren, Findings From the Survey of Health, Ageing, and Retirement in Europe."

128 Ochiltree, *Grandparents, Grandchildren and the Generation in Between*; Ochiltree, "The Changing Role of Grandparents."

129 Štifter, et al., „Razlozi razvoda braka kao odrednice sporazuma o roditeljskoj skrbi."

Figure 41 Separation of older and younger generations: 1) Two-entry apartment (TT3 Soho, Kuching, Ibraco Berhad, 2022); 2) Dual-key apartment (Tembusu housing, Singapore, Arc Studio Architecture + Urbanism, 2018); 3) Separate room in an apartment (Apartment in Belgrade Street, Belgrade, Studio Alfirevic, 2019) (Source: Author's archive)

bathroom.[130] Optimal spatial arrangements conducive to fostering intergenerational cohabitation involve having two distinct residential areas with separate entrances to the apartments, interconnected internally through an entrance area or vestibule, facilitating close family ties as needed. While this setup can be more complex to implement, given the need for an additional housing unit within a larger apartment, there exist housing models that provide comfort for all three generations, such as "dual key apartments," where two living units share a common anteroom and a single entrance door.[131] Conversely, a less ideal option entails allocating a separate room for the third generation near the kitchen and bathroom, allowing for short-term or conditional long-term cohabitation, contingent upon mutual respect and understanding between parents and grandparents. (Figure 41)

4.2.5. Separation of common from individual spaces

The division of smaller apartments into shared and individual spaces typically corresponds to the separation into daytime and nighttime areas.[132] In larger apartments, specialized spaces for socialization and hosting guests (such as a living room, study, media room, etc.) often exist, blurring the line between shared and individual areas to some extent. An essential aspect of each living

130 Yang, Oldfield and Easthope, "Influences on Apartment Design: A History of the Spatial Layout of Apartment Buildings in Sydney and Implications for the Future."

131 Alfirević and Simonović Alfirević, "Spatial Organisation Concept of Two-Entrance Apartment."

132 Nowakowski, "Ergonomic Shaping of Functional and Spatial Program of Housing."

space's configuration is the "territoriality boundary."[133] The term "territoriality" primarily denotes an individual's or group's behavioral pattern based on the need to control a specific physical space (which can also include an object or idea). The concept of a territoriality boundary suggests a temporary distinction between the "private" (family and intimate) and "public" (social) zones within the apartment—this delineates the area that someone is allowed or expected to enter before the resident feels their privacy is compromised. While in smaller structures, this boundary often aligns with the division into daytime and nighttime areas or private and social zones, in larger ones, it can vary and adapt to different user needs, as demonstrated by examples showcasing the flexible utilization of living space.

The concept of a territoriality boundary in residential spaces, manifesting as a "social filter," stems from the recognition that individuals naturally develop a sense of territoriality towards others in various spaces. This sense operates at different levels, encompassing intimate space, personal space, and social space.[134] (Figure 42) These zones denote varying degrees of comfort or anxiety concerning the presence of others within the same space. Their significance is relative, influenced

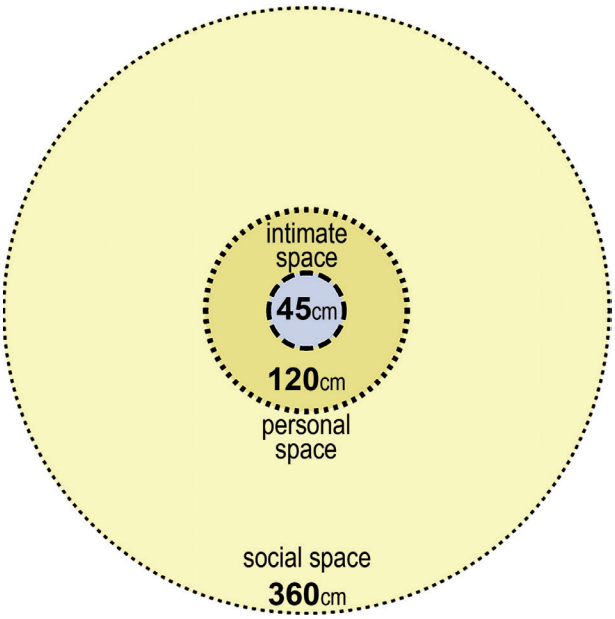
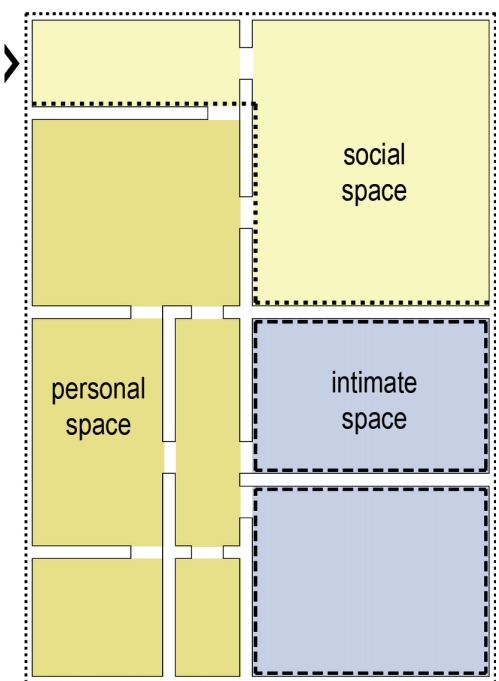


Figure 42 Experience of territoriality: 1) in personal relations and 2) in residential space (Source: Authors' archive)



133 Edney, "Human Territoriality."

134 *Intimate distance* refers to a range of up to 45 cm, designated for extremely close individuals such as family members, partners, or trusted individuals. Approaching someone this closely whom we are not intimately close to can be quite discomforting. *Personal distance* encompasses a range of 45–120 cm, where we typically engage with friends, shake hands, and are able to observe their body language and eye movements. *Social distance* extends from 120 to 360 cm and is often observed during interactions with less familiar or unknown individuals. In such situations, people tend to speak more loudly, and eye contact becomes more necessary. (Hall, *The Hidden Dimension.*; Efran and Cheyne, "Shared Space: The Co-Operative Control of Spatial Areas by Two Interacting Individuals.").

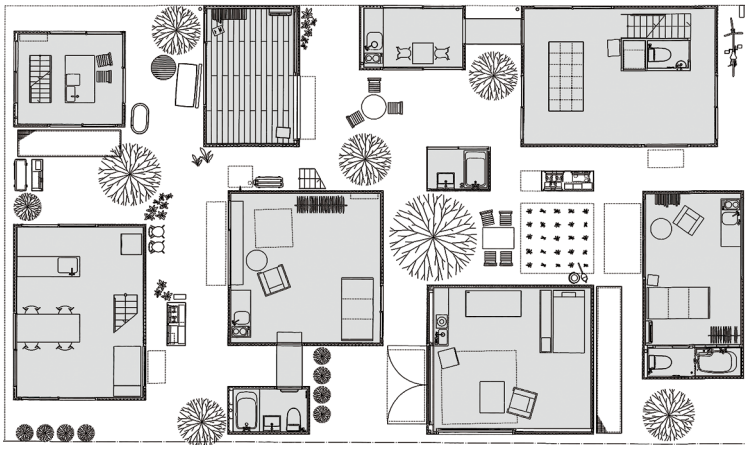


Figure 43 Differentiation of functions into shared and individual spaces (Moriyama House, Tokyo, SANAA, 2005) (Source: Authors' archive)

by cultural norms and individual personality traits.[135] It's noteworthy that alongside individual territoriality, there exists group territoriality, particularly within residential contexts, where the family acts as the primary user of the space. Drawing from the perspective of theorist Douglas Porteous, who posits that "the house mirrors how an individual perceives themselves, their aspirations, and their desired image,"[136] it becomes apparent that the arrangement of residential space, territorial boundaries, social space dynamics, and the layout of communal areas reflect the user's social needs and material circumstances.[137]

An extreme example showcasing the separation between shared and individual spaces is the Moriyama House (Tokyo, SANAA, 2005), where the authors ingeniously dissected residential functions to form a cohesive composition. They treated the interstitial space between volumes as a significant factor, effectively integrating the entire structure into a harmonious whole. (Figure 43)

135 Sorokowska, Sorokowski and Hilpert, "Preferred Interpersonal Distances: A Global Comparison."; Strube and Werner, "Interpersonal Distance and Personal Space: A Conceptual and Methodological Note."; Gifford, "The Experience of Personal Space: Perception of Interpersonal Distance."

136 Porteous, "Home: The Territorial Core."

137 Ristić, „Stambena arhitektura elite kao prostor za performans društvenih vrednosti."

4.3. Positioning of functions

4.3.1. Secondary center

Functionally speaking, the heart of residential spaces encompasses areas designed for hosting visitors and accommodating its occupants. Typically, there is at least one focal point where people gather regularly, usually situated within the daytime zone. When multiple gathering points exist—two, three, or more—their placement, size, and connectivity define the functional organization and reflect the social needs of the residents. These types of residential spaces are referred to as "polycentric spaces" in architectural theory.[138]

When discussing the spatial organization of an apartment or house, the term "center" usually implies a room or element situated in a central position and occupying a prominent place within the overall structure. Functionally and within the scope of this research, the term "center" pertains to a space where occupants gather to fulfill various social needs such as socializing and engaging in conversations. In contemporary residential settings, this gathering function can be fulfilled by spaces like the

138 Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*.

living room, family room, media room, salon, or dining room. The emphasis placed on the gathering center in a residential space may vary based on the architect's approach and the specific needs of the users, thereby influencing the spatial and functional concept of the space.[139]

Depending on the structure, geometry of the space, users' needs, and other factors, in addition to the main gathering center, there may be at least one secondary center, whose primary role is to separate simultaneous activities of different users in the same space. The necessity for establishing a secondary center in residential areas is particularly common in households with multiple members, where the needs of users often vary across different generations (parents-children, elderly-young). Having only one central gathering point can potentially lead to conflicts, especially when the social engagements of younger family members coincide with activities involving adult guests.[140]

The concept of organizing residential space with two centers remains relatively underexplored in scholarly discourse, despite its widespread practical implementation. Generally, every residential space can be divided into at least two zones - day and night, which stems from organizing residential functions based on users' biological rhythms.[141] Alternatively, spaces can be divided into three functional units, distinguishing between intimate, shared, and householding areas.[142] Differentiating spaces can also involve considering the level of intimacy, dividing them into private (intimate and shared) areas and the social area of the apartment[143], such as spaces designated for hosting guests.[144] The utilization of spaces for gatherings and hosting reflects the unique identity of each family, fostering subtle bonds that contribute to a sense of unity and familial cohesion.[145]

The most common gathering centers found in residential spaces include the living room, family room, media room, lounge, dining room, among others. In residential spaces of medium to lower standards, the living room typically serves as the central gathering space for users, while the dining room area, closely linked to the living area, is also engaged as needed.[146] As standards rise and residential spaces grow in size and complexity, the living room often takes on a more elegant design and becomes primarily reserved for hosting guests and for special occasions. Recent research indicates that the living room is also frequently used as a serene retreat from the family's daily activities, which tend to occur in the family room.[147] The term "living room" was adopted only by the late 19th and early 20th centuries, while the earlier term for a reception space was the vestibule.[148] Its primary role is to provide comfort to visitors and to showcase how an

139 Alfirević and Simonović Alfirević. "Constitutive Motives in Living Space Organisation."

140 Montgomery, "The Housing Patterns of Older Families."

141 Marušić, *Projektovanje 2: Višeporodično stanovanje – Sveska 6*, 7.

142 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*.

143 The term „social zone of the dwelling" lacks a clear definition in the literature despite its common usage. For the purposes of this paper, it refers to the area of residential space accessible to visitors (guests), while the user (host) does not experience any compromise in privacy or a sense of diminished privacy.

144 Knežević, *Višestambene zgrade*.

145 Fiese, *Family Routines and Rituals*.

146 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

147 Rechavi, "A Room for Living: Private and Public Aspects in the Experience of the Living Room."

148 In Western culture, particularly in the Anglo-Saxon region, various terms are used interchangeably to refer to the living room, including: *parlor*, *drawing room*, *sitting room*, *lounge room*, *lounge*, *front room*, *reception room* etc.

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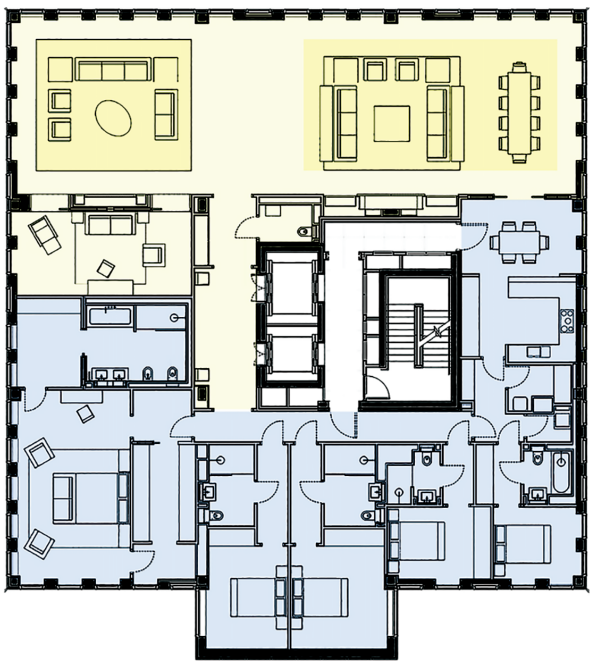

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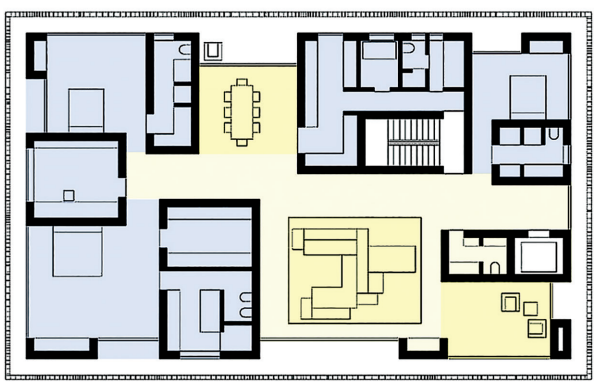


individual or family wishes to present themselves.[149] This space is typically designed to be bright, spacious, and conveniently located near the main entrance, allowing guests to enter the reception area directly without passing through private or intimate spaces.[150] In many cultures, the living room is the most visited area, often considered the "face" or "front" of the residential space due to its frequent use and role in welcoming guests.[151]

In contrast to the living room, the family room typically serves as a secondary center in large residential spaces, and is less formal both in terms of organization and furnishings. It is usually located away from the main entrance, often adjacent to the kitchen or dining area. The family room is primarily used for daily family gatherings, recreational activities, relaxation, and children's play, with a focus on creating a comfortable and cozy environment.[152] In smaller residential spaces, the family room may assume the functions of a traditional living room, consolidating various life activities into a single adaptable space. However, this consolidation can present functional challenges in certain situations. Given that the family room tends to be one of the most intensively used spaces, it is essential to design it with adequate dimensions to accommodate all family members comfortably. In very large spaces (500-1000

149 Goffman, *The Presentation of Self in Everyday Life*.

150 Cromley, "Domestic Space Transformed, 1850–2000."

151 Nasır, Ogut and Gürel, "Changing Uses of the Middle-Class Living Room in Turkey: The Transformation of the Closed-Salon Phenomenon."

152 Cromley, "Domestic Space Transformed, 1850–2000."

Figure 44 Typical examples of residential spaces with centers grouped in the social zone: 1) 87 Mercer Street penthouse, New York (Tony Ingrao); 2) Holland Green, London (OMA & Allies & Morrison, 2016); 3) Ninetree Village, Hangzhou (David Chipperfield Architects, 2008). (Source: Authors' archive)

m^2), activities commonly conducted in the family room may be subdivided into multiple smaller centers, such as a media room or a dedicated children's playroom. This approach ensures that each area provides sufficient comfort and functionality tailored to the needs of its users.

The dining room's function can vary depending on the size of the residential space, serving both as a "family table" for daily meals and as a venue for receptions and occasional celebrations. In larger residences, there is often a formal dining room positioned near the living room, complemented by a smaller dining area adjacent to the family room for everyday use. While the dining room typically plays a secondary role compared to other gathering spaces, certain design concepts, such as the "salon" apartments built in Serbia between the two World Wars, emphasize its significance in spatial organization due to its size and position.[153]

4.3.1.1. Residential space with centers grouped in the social zone

Connecting gathering centers is primarily characteristic of versatile residential spaces where an open-plan concept is applied. The degree of internal openness depends on: 1) residents' lifestyle and habits, 2) their health and age, 3) the design and arrangement of load-bearing structures, 4) family structure, and life organization within the residential space, etc.[154] The integration of centers within the social zone is primarily dictated by these parameters, especially the residents' lifestyle and habits. This concept is driven by several motives, including the desire for ample space for regular social interactions with friends and extended family, as well as the intention to showcase and highlight social status. By grouping centers in the same space, allows certain residential functions, such as family rooms and dining spaces, to extend into the social zone, thereby blurring the boundaries and creating a sense of expansive and representative space. In some cases, the social zone's scale can heavily influence spatial design, with reception areas occupying a substantial portion of the residential layout. These trends often indicate a high level of extroversion among residents, where socialization and presentation play significant roles in their daily routines. (Figure 44)

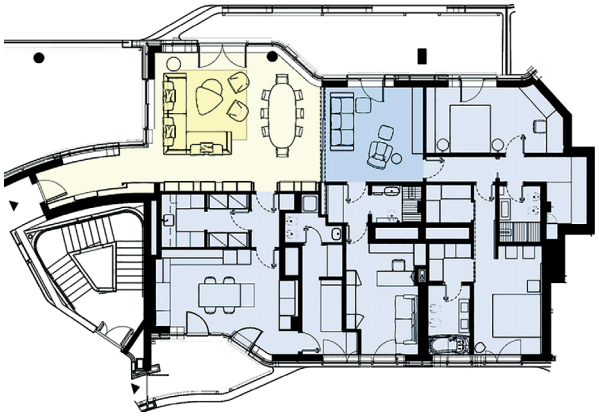
In smaller residential spaces, the interconnection of centers holds considerable importance. Due to spatial constraints, positioning the dining area adjacent to the living room within the "extended circulation area" fosters a perception of increased spaciousness. This arrangement leads to the establishment of two distinct centers: 1) the primary center being the living area, and 2) the secondary center serving as the family gathering space around the dining table, situated apart from the kitchen area.

4.3.1.2. Residential space with a flexible center at the boundary between zones

Positioning the center at the boundary between the social and private zones of residential space offers flexibility in usage, achieved through the ability to separate or connect centers. Removing the flexible barrier extends the social zone to encompass the gathering space within the private zone, albeit temporarily disrupting functional relationships and eliminating the option for part of the family to convene in a more intimate space during visits. Conversely, partitioning the space and segregating the centers create the necessary conditions for different intensities and modes of usage. This approach to center positioning facilitates the fulfillment of diverse social needs among users, particularly when combined with the concept of organizing residential space with two entrances, thereby ensuring autonomy between the social and private zones over an extended period. Depending on whether family spaces are consolidated

153 Alfirević i Simonović Alfirević, „'Salonski' stan između dva svetska rata u Srbiji: Preispitivanje opravdanosti korišćenja termina."

154 Čanak, „Otvoren ili zatvoren stan."



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or divided into blocks (such as parents' and children's areas), and whether the entrance to the social zone is positioned at a corner or in the middle of a side, the number of centers in residential space can vary. The highest level of spatial comfort is achieved by separating the living room and dining area within the social zone, while the kitchen and family room form an autonomous unit with an intimate zone. Integrating the kitchen into the social zone characterizes an extroverted functional organization concept, where a portion of the private zone is exposed to visitors' view. (Figure 45)

4.3.1.3. Residential space with a secondary center in the private zone

The clear functional separation of centers in different zones is a prominent feature of residential spaces with expansive areas and multiple rooms. This delineation is not only evident in large spaces but also in cases where specific (introverted) user needs demand a strict division between social and private zones. This spatial organization concept finds particular suitability in multi-member households, including two-generation or three-generation families, due to the distinct need for segregation arising from varying life rhythms. The advantages of this concept are magnified when the living space is accessible through multiple entrances, allowing each zone to operate independently while remaining part of a cohesive whole. Secondary centers positioned deep within the private zone, surrounded by intimate spaces, serve primarily for intimate conversations among users. However, a potential issue with this concept is the risk of segregating users. In situations where each member has their dedicated personal space and gathering centers are physically isolated, there is an increased likelihood of weakening intimate relationships among users, potentially leading to feelings of alienation. (Figure 46)

Figure 45 Typical examples of residential spaces with a flexible center on the boundary between zones: 1) Citylife Residential Complex, Milano (Zaha Hadid Architects, 2016); 2) Karlatornet, Gothenburg (Skidmore, Owings & Merrill, 2019); 3) 900 North Avenue, Chicago (Kohn Pedersen Fox Associates, 1989) (Source: Authors' archive)

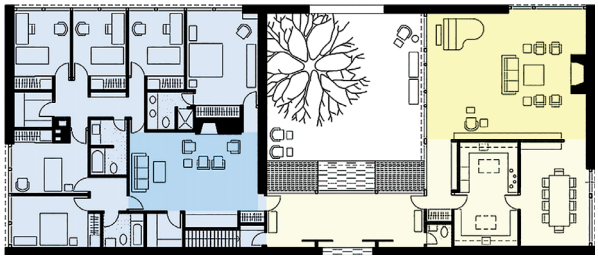

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Figure 46 Characteristic examples of residential spaces with a secondary center in the private zone: 1) Hooper House I, Baltimore (Marcel Breuer, 1960); 2) 432 Park Avenue, New York (Rafael Viñoly, 2015) (Source: Authors' archive)

The three fundamental concepts of center arrangement in residential space configurations indicate their impact on the level of intimacy they offer. (Figure 47) The analysis results suggest that the most versatile concept, which features a secondary center positioned at the boundary between zones, has the widest range of benefits. This concept combines the advantages of the other two more extreme concepts, offering a balanced approach that caters to a broader spectrum of needs. (Table 4)

In addition to the concepts mentioned, there are others to consider, such as those that do not involve receiving guests in residential spaces, thus eliminating the need for a dedicated social zone. Alternatively, in scenarios where creating a social zone is not feasible, visits may occur in the family zone. In larger residential spaces with clearly defined social and private zones (family and intimate), three distinct territorial boundaries may emerge: the "ownership boundary," "hospitality boundary," and "intimacy boundary." In smaller apartments where the social zone is less defined, the hospitality boundary may approach or overlap with the intimacy boundary. An extreme scenario arises when visitors are not hosted in the living space, aligning the hospitality boundary with the ownership boundary. User preferences for distinct centers and their design choices can sometimes result in oversized gathering spaces and undersized private areas, leading to an imbalance between the social and private zones. From these considerations, it is evident that the extroversion level of residential space is closely tied to the users' characteristics and needs, including how they wish to present themselves to visitors, along with the cultural context.

Figure 47 Characteristic positions of gathering centers in residential spaces concerning the boundary between social and private zones. (Source: Authors' archives)

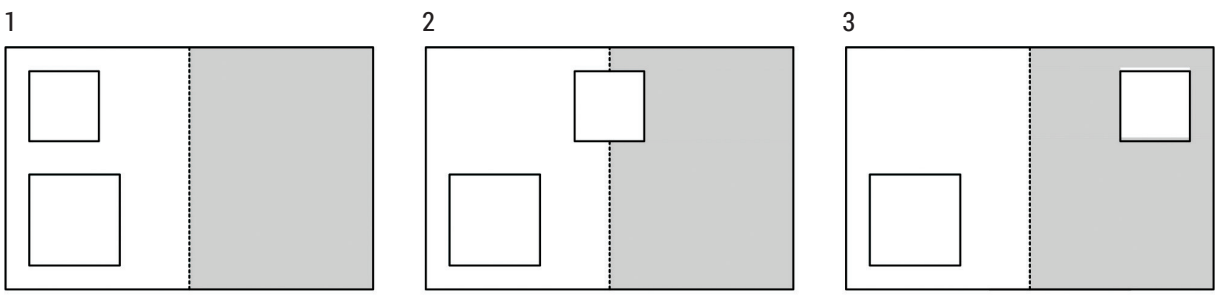


Table 4 Tabular representation of analyzed concepts

	Centers grouped in the social zone	Flexible center at the border between zones	Secondary center in a private area
Functional conception	"extroverted"	combined	"introverted"
User motives	spatial need for frequent social interactions	spatial need for occasional social interactions	spatial need for frequent or occasional social contacts
	need for presentation and status display	spatial need for informal family gatherings	spatial need for informal family gatherings
The character of the space	polyvalent (open plan)	flexible	segmented
User profile	one-generation households, two-generation households	two-generation households, three-generation households	two-generation households, three-generation households
Advantages	the existence of a permanent and clearly defined reception and socialization zone	possibility of forming a larger zone for receptions and socialization	the existence of a permanent and clearly defined reception and socialization zone
	---	possibility of simultaneous activities segregation in the social and family zone	segregation of simultaneous activities in the social and private zones
Deficiencies	activities in the social zone interfere with simultaneous activities in the private zone	activities in the social zone can interfere with simultaneous activities in the private zone	segregation of users and the occurrence of potential alienation

4.3.2. Extended circulation area

The concept of an extended circulation area held significant importance within the Belgrade School of Housing and functional organization, particularly in the post-World War II era with the development of the "Belgrade apartment."[155] This concept bears similarities to an earlier concept seen between the two World Wars in Serbia, known as the central multipurpose room in "salon" apartments, which served various functions like dining, hosting guests, and celebrations. According to Mirko Todorović, the idea of a shared space of the apartment for family gatherings and receiving guests marked a progression from the „salon" Belgrade apartment in the early modern period. Similar examples of implementing an extended circulation area with a shared table were found both domestically and internationally during that era, including the interwar period.[156] Post-World War II, the extended circulation area gained prominence due to the aim of creating two distinct centers within the apartment layout: 1) the primary center being the living room and 2) the secondary one serving as a space for family gatherings around the dining table, separate from the kitchen area.[157] Professors Mate Bajlon, Branislav Milenković, and Branko Aleksić from the Faculty of

155 Nestorović, „Evolucija beogradskog stana."; Alfirević i Simonović Alfirević, „Beogradski stan."

156 Todorović, *Doprinos standardizaciji kvaliteta organizacije prostora stana u Srbiji na osnovu savremenih principa stambene izgradnje u Holandiji*.

157 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*.

Architecture at the University of Belgrade were key advocates for expanding this concept in Yugoslavia. It is considered that the term "extended circulation area" was first publicly used by Bajlon at the FAO Seminar held in Belgrade in 1957.[158] Bajlon emphasized that this concept stemmed from the necessity to facilitate family gatherings around a shared table, especially in cases where space constraints prevented it, thus becoming an integral addition to the living room.[159] However, Bajlon also cautioned against the incorrect practice of incorporating a single bed into the living room, which he argued was not in alignment with the essence of life nor with the concept of extended circulation area.[160] Vladimir Lojanica further elaborated that the emergence of the extended circulation area was a response to the need for increasing individual apartment space while maintaining a suitable living area per family member, thus promoting the idea of communal family gatherings around a shared table.[161]

The concept of extended circulation areas, particularly in challenging socio-economic contexts, offered diverse possibilities such as: 1) creating an entrance area for receiving guests, 2) establishing an everyday area for children's activities like learning and play, 3) separating children's activities and their social circle from parents' activities and their friends, 4) enhancing the overall spaciousness of the apartment, etc. Despite its theoretical advancements relative to its time and circumstances, practical implementation sometimes led to misinterpretations. This was evident when the extended circulation area was erroneously substituted for the living room, a trend supported by contemporary norms.[162] Consequently, the living room would often be repurposed to accommodate additional family members for sleeping, detracting from the overall comfort of the apartment. The concept of extended circulation area gained more traction and practical application during the 1970s, undergoing verification initially through student projects under the guidance of professors Mate Bajlon and Branko Aleksić, and subsequently through public competitions in Yugoslavia. In theoretical research conducted by Bajlon and his colleagues, they demonstrated that the integration of a shared table within the extended circulation area could be approached in two primary ways: by situating the extended circulation area on the outer perimeter of the apartment with direct natural light, such as from a balcony or loggia, or by incorporating the extended circulation area inside the apartment and illuminating it through a glass surface connecting to the kitchen or through artificial lighting.[163]

The notable implementations of the extended circulation area concept in Serbia encompass residential developments such as those in Blocks 70 and 45 in New Belgrade (Risto Šekerinski, 1970), residential buildings in Block 22 in New Belgrade (Božidar Janković, Branislav Karadžić, Aleksandar Stjepanović, 1974), residential buildings in the Banjica settlement in Belgrade (Aleksandar Stjepanović, Branislav Karadžić, Slobodan Drinjaković, 1972-1976), competition solution for residential buildings in the Julino Brdo settlement in Belgrade (Branko

158 Bajlon, *Upotrebna vrednost stana*; Dragutinović, et al., "Modernism in Belgrade: Classification of Modernist Housing Buildings 1919–1980."

159 Bajlon, „Neka pitanja u vezi sa upotrebnom vrednosti stana, stan i stanovanje."

160 Bajlon, Upotrebna vrednost stana.

161 Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*, 201.

162 "Instruction for the Construction of Residential Buildings for the Needs of the Yugoslav People's Army (JNA)", State Secretariat for National Defense, 1955; "Conditions and Technical Standards for Designing and Construction of Residential Buildings and Apartments," Directorate for Urban Construction of Belgrade, 1973; "Temporary Standard for Directed Construction Housing," Building Center of Slovenia (Ljubljana), Housing Center IMS (Belgrade), 1973. (Bajlon, *Upotrebna vrednost stana*; Ćirović, "Housing Policy and Culture in Yugoslavia: The Case of the Exhibition 'Housing for our Conditions' in Ljubljana, 1956.")

163 Milošević, *Mate Bajlon, arhitekta (1903–1995)*.

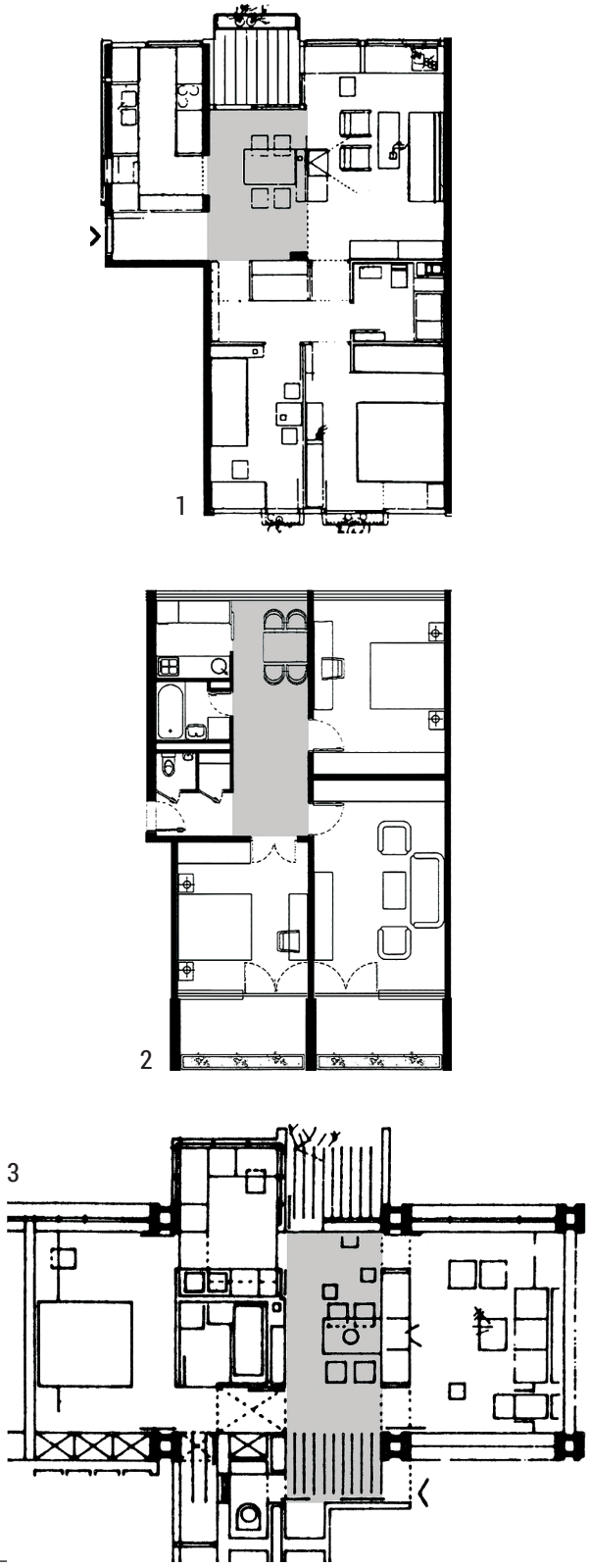


Figure 48 Apartments with extended circulation area: 1) Senjak Settlement, Osijek (Vladimir Tvrtković, 1968–1975) (above); 2) Blocks 45 and 70, New Belgrade (Risto Šekerinski, 1970) (middle); 3) Block III, Novi Sad (Milan Lojanica, Predrag Cagić, Borivoje Jovanović, 1970-1971) (below). (Source: Authors' archive)

Aleksić, 1966), residential complex in Vojvode Stepe Boulevard in Belgrade (Branko Aleksić, Nikola Saičić, 1973), and others.[164] The effectiveness and quality of the apartment are influenced by the position of the extended circulation area. Typically, it is integrated as an extension of the entrance area, thereby creating a more spacious hallway (seen in Blocks 45 and 70 in New Belgrade, as well as Block III in Novi Sad, among others). Alternatively, it can serve as a visual extension of the living room (observed in Block 22, 23, and 29 in New Belgrade), which adds a unique quality to the apartment akin to the open plan concept.[165] (Figure 48)

4.3.3. Central multipurpose space

One of the rooms in a house or apartment can serve as a central motif around which the entire layout revolves, particularly when it serves multiple functions for specific reasons. This central positioning often amplifies its dimensions and underscores its significance within the overall concept. A notable historical example of this approach can be seen in centrally planned apartments, commonly known as "salon" apartments, constructed in Serbia between the two world wars. The central anteroom within the layout of a "salon" apartment held considerable importance, functioning as an extended circulation area with a dining function. This room was not only central in position but also had a representative character, often serving as a venue for formal gatherings

164 Aleksić, „Konkursni stan."

165 Alfirević i Simonović Alfirević, "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."; Čanak, „Otvoren ili zatvoren stan."

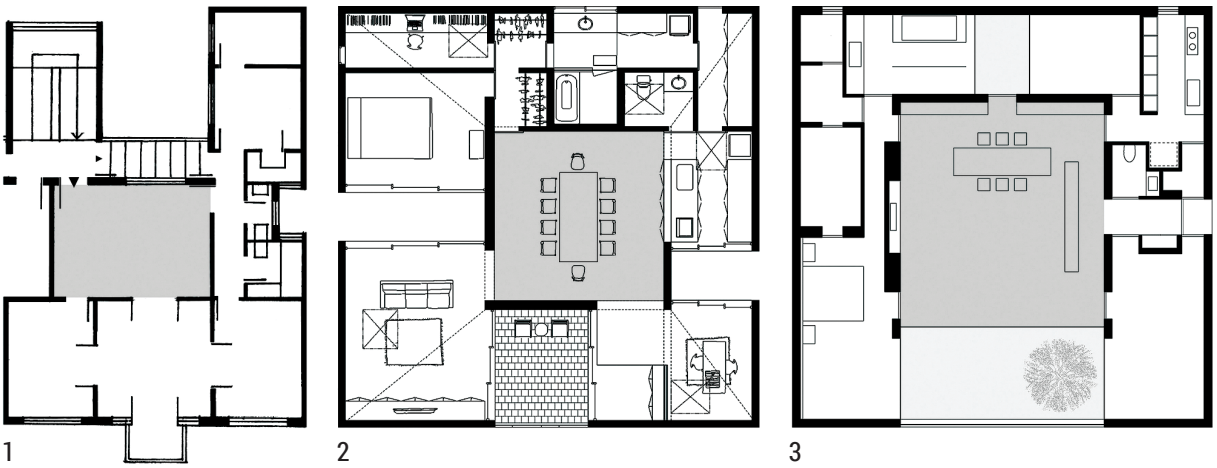


Figure 49 The motif of a multipurpose space as a core: 1) Typical "salon" apartment, Belgrade; 2) House Yagiyama, Sendai, Kazuya Saito Architects, 2012; 3) Library House, Tochigi, Shinichi Ogawa, 2012 (Source: Authors' archive)

and celebrations.[166] In contemporary apartment designs, the trend leans towards open-plan layouts, where a unified living room, dining area, and kitchen form the core of the layout without partitions. Additional residential spaces are then connected independently or in clusters to this central core. For instance, in House Yagiyama (Sendai, Kazuya Saito Architects, 2012), the central room is specifically dedicated to a formal dining area, highlighting its role in family gatherings and daily life. Conversely, in the Library House (Tochigi, Shinichi Ogawa, 2012), a multipurpose space serves as the central motif, seamlessly integrating functions such as a living room, dining area, and library, with other spaces arranged around it. (Figure 49)

4.3.4. External "transitional" space

Open spaces like terraces, balconies, and verandas, situated at the interface of interior and exterior areas, are common features in residential complexes. Despite often being considered secondary spaces due to their lower frequency of use, these areas play a significant role in certain design concepts. Nevertheless, in practice, there are concepts in which the existence of external "transitional" space is of particular importance.[167] One of the earliest applications of this motif can be found in traditional Japanese houses, where the covered engawa space extended residential areas into a terrace, providing views of natural surroundings or Zen gardens.[168] Following a similar approach, the Wee House in Santa Rosa (Alchemy, 2016) incorporates communication between spatial-functional units that also functions as a terrace. In the concept of units within the residential tower "Y" in Kragujevac (Dragoljub Bakić, 1978), the veranda motif takes on primary importance. Here, the central position

166 Nestorović, „Evolucija beogradskog stana."; Alfirević i Simonović Alfirević, „Beogradski stan."

167 Stanimirović i Jovanović, „Lođa kao ulazna zona stana."

168 Tadej, *Stanovanje u Japanu*.

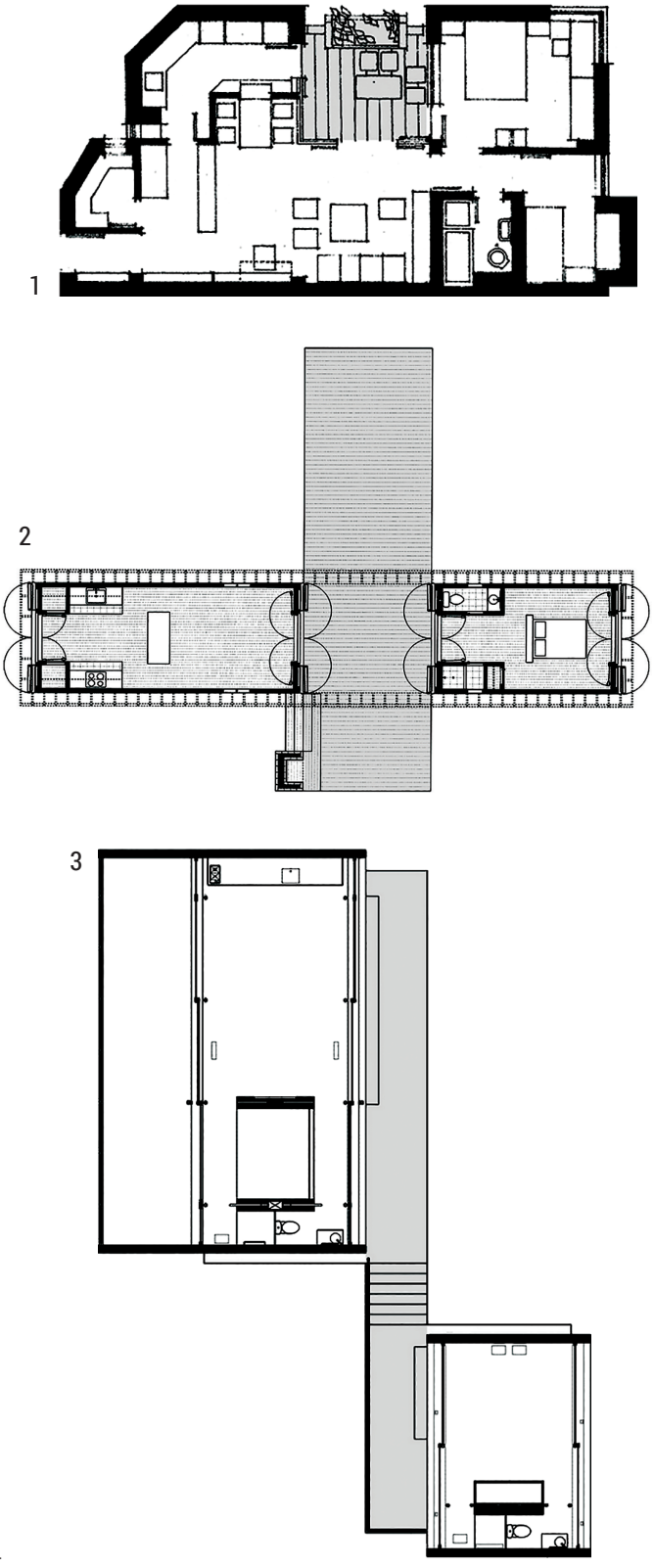


Figure 50 The motif of external "transitional" space: 1) Residential Tower "Y", Kragujevac, Dragoljub Bakić, 1978; 2) Zachary House, Louisiana, Stephen Atkinson, 2012; 3) Wee House, Santa Rosa, Alchemy, 2016 (Source: Authors' archive)

of the veranda and the arrangement of spaces around it aim to enhance individuality and reduce potential fear of heights associated with tall buildings.[169] The Zachary House in Louisiana (designed by Stephen Atkinson in 2012) features a covered terrace with dual purposes — it serves both as an entrance hall-communication area and as a terrace, positioned between two functional blocks to both segregate and unify the space. Similarly, an apartment in the Bilj Brig settlement in Zadar (designed by Nikola Bašić in 1991), as mentioned by authors Marušić, Stanimirović, and Jovanović, utilizes the veranda as both the apartment's entrance area and an outdoor living space, highlighting its versatile and dual-purpose character. (Figure 50)

4.3.5. Inner courtyard

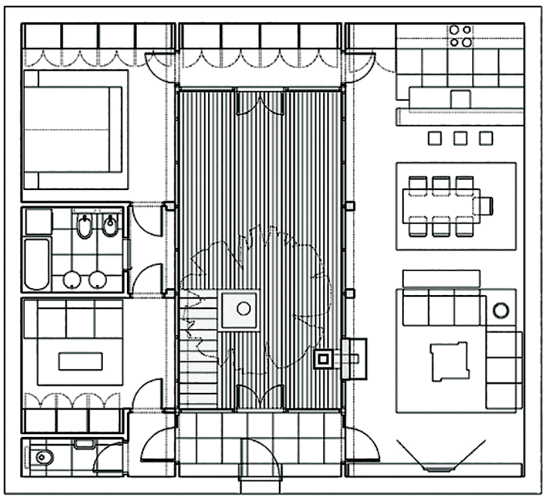
The motif of the inner courtyard stands as one of the oldest and enduring motifs in architecture, maintaining relevance in contemporary architectural practice. When comparing traditional houses with inner courtyards to modern examples, a striking difference lies in the inner courtyard's role in shaping the fundamental concept of the architectural ensemble. Atriums were historically significant in providing safety and protection from excessive sunlight in hot climates. In contemporary practice, they often reflect an introverted desire for privacy.[170] For an architectural design to be

169 Bakić, *Anatomija B&B arhitekture*.

170 Abass, Hakim Ismail and Solla, "A Review of Courtyard House: History Evolution Forms, and Functions."

defined by its inner courtyard as the primary motif, a fundamental requirement is that all spaces within the ensemble receive direct or indirect illumination from the central atrium. This spatial organization was prevalent in traditional houses with inner courtyards.[171] Contemporary houses with atriums differ in that they are not exclusively introverted; they open up to the surroundings at specific points. Nevertheless, the central positioning of the atrium with residential spaces oriented around it indicates a clear adherence to the concept based on the constitutive motif of the inner courtyard.

This approach is evident in the Solar Atrium House project (Topola, Studio Alfirević, 2013), while in the Earth House (Yangpyeong-gun, BCHO Architects, 2009), the inner courtyard is positioned on the periphery of the ensemble, influencing the orientation of the main residential spaces towards a sunken courtyard. While many examples with inner courtyards focus on organizing spaces around a central point, there are exceptions such as the unrealized project Houses with courts (Mies van der Rohe, 1931) and Weekend House (Usui-gun, Ryue Nishizawa, 1997). In these cases, residential spaces are oriented towards two or even three atriums, showcasing a departure from the typical single-centered approach. (Figure 51)



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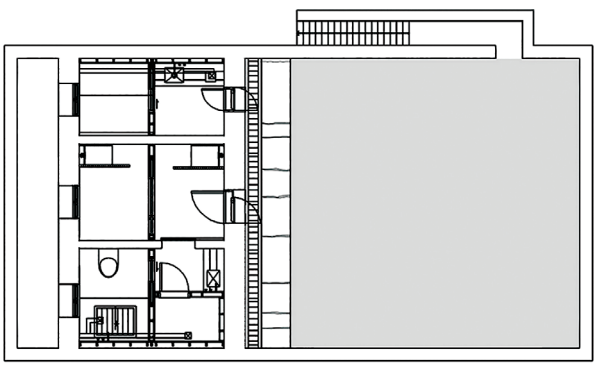

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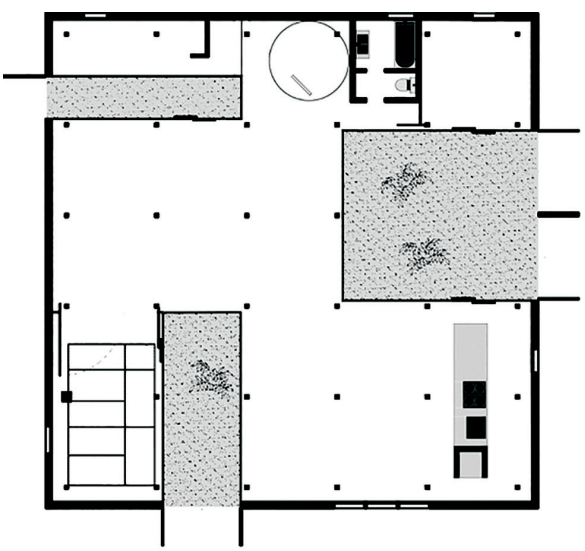

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171 Rapoport, "The Nature of the Courtyard House: A Conceptual Analysis."

Figure 51 Inner courtyard motif: 1) Solar Atrium House, Topola, Studio Alfirević, 2013, 2013; 2) Earth House, Yangpyeong-gun, BCHO Architects, 2009; 3) Weekend House, Usui-gun, Ryue Nishizawa, 1997 (Source: Authors' archive)

4.4. Polyvalence of functions

The term "polivalence" (Greek: poly - multiple, Latin: valentia - value, multifunctional) is a concept widely embraced in both scientific and artistic realms. Polivalence typically denotes the versatility of a space, indicating its ability to serve various human needs with minimal physical alterations. In scientific contexts, "polivalence" in residential architecture generally pertains to the adaptability of an entire apartment or house, allowing for the reorganization of internal structures or the repurposing of spaces, which represents a broader interpretation of the concept. Conversely, there exists a more specific interpretation focusing on the polivalence of individual parts of an apartment, a single space, or a room. This narrower view highlights the capacity of such spaces to accommodate overlapping residential functions at different times, often associated with an open plan.

The term "polivalence" has long been part of architectural discourse, particularly in reference to multifunctional spaces or "polivalent halls" (salle polyvalente) found across France, utilized for various public activities.[172] It is believed that the term was first introduced into architectural terminology by the Dutch architect Herman Hertzberger through his Diagoon housing project (Delft, 1970). Hertzberger's aim was to promote freer use of living spaces while also critiquing the concept of flexibility.[173]

The term flexibility can be interpreted in several ways. It is typically associated with configuring a space that becomes physically different by moving walls and partitions. Additionally, it may refer to the variability and adaptability of shapes (such as furniture or equipment, less frequently parts of the house) to different living needs. It can also relate to the adaptability of purpose or use within the same fixed spatial framework, equating it with the concept of polyvalence.[174]

There has been a significant amount of literature discussing polivalence in architecture. Noteworthy among these are essays by Herman Hertzberger[175] and Bernard Leupen,[176] which have become foundational references for subsequent authors in this field.[177]

172 Leupen, "Polyvalence, a Concept for the Sustainable Dwelling."

173 Brinkenberg and Miettinen. Home Free Home: *A Polyvalent Approach to Housing*. .

174 Canepa, "*Living in a Flexible Space.*"; De Paris and Nuno Lopes, "Housing Flexibility Problem: Review of Recent Limitations and Solutions."

175 Hertzberger, "Flexibility and Polyvalency."; Hertzberger, *Lessons for Students in Architecture*; Hertzberger, "Polyvalence: The Competence of Form and Space With Regard to Different Interpretations."; Hertzberger, *Architecture and Structuralism: The Ordering of Space*; Hertzberger, "*Diagoon Housing, Delft, 1967–1970.*"

176 Leupen, "The Frame and the Generic Space: A New Way of Looking to Flexibility."; Leupen, "Polyvalence, a Concept for the Sustainable Dwelling."; Leupen, "The Polyvalent Dwelling."

177 Brinkenberg and Miettinen, *Home Free Home: A Polyvalent Approach to Housing*; Femenias and Geromel, "Adaptable Housing? A Quantitative Study of Contemporary Apartment Layouts That Have Been Rearranged by End-Users."; Seo and Kim, "Interpretable Housing for Freedom of the Body: The Next Generation of Flexible Homes."; Kim, "On Flexibility in Architecture Focused on the Contradiction in Designing Flexible Space and its Design Proposition."; Manum, *Apartment Layouts and Domestic Life: The Interior Space and its Usability: A Study of Norwegian Apartments Built in the Period 1930–2005*; Montellano, "Housing Flexibility by Spatial Indeterminacy: The Case of the Casa de las Flores in Madrid."; Yunitsyna, "Universal Space in Dwelling–The Room for All Living Needs."; Yunitsyna, "Universal Space in Dwelling and Methods of its Spatial, Functional and Structural Analysis."; Hill, "An Other Architect."; Krokfors, *Time for Space: Typologically Flexible and Resilient Buildings and the Emergence of the Creative Dweller*; Kubet, „Novi aspekti fleksibilnosti stambenih prostora."; etc.

Critiquing flexibility, Herman Hertzberger states that "flexible design starts from the certainty that there is no correct solution because the problem requiring a solution is constantly evolving, i.e., it is always temporary. [...] Flexibility supposedly embodies relativity, but in reality, it is only connected to uncertainty; without daring to commit, and therefore with a refusal to accept the responsibility that is inevitably associated with every action you take. [...] Flexibility thus represents a set of all inappropriate solutions to the problem."[178] While this assertion is sharp and perhaps overly critical, as it challenges the long-standing principle of flexibility in architecture, it is significant in prompting a change in perspective that has led to reflections on polivalence. As a solution to this problem, Hertzberger emphasizes that "the only constructive approach to a situation that is subject to change is a form that starts from this variability as a constant, essentially static factor: a form that is polivalent. In other words, a pattern that can be used for different purposes without the need to change itself, so that minimal flexibility can still produce an optimal solution."[179] This criticism, although aiming to challenge or at least reduce the importance of flexibility, underscores a different view of variability in architecture, presenting polivalence as a solution to an age-old "problem." Despite the subjective nature of this critique, the principle of polivalence indeed offers theoretical potentials that can advance the functional organization of space.

Bernard Leupen expands on Hertzberger's views, focusing his research on analyzing characteristic examples of polyvalent residential architecture to establish fundamental principles of polyvalence. His standpoint, summarized as "the polyvalence of living spaces depends on spatial organization," significantly influences the scope of observation and formulation of principles because polyvalence is primarily about hypothetical possibilities of reorganizing activities within an apartment's rooms.[180] However, a limitation of this standpoint is that Leupen's analysis often overlooks the distinction between optimal, acceptable, and illogical changes in activity locations. This oversight can limit the exploration of potential variations. Despite this limitation, Leupen's research contributes by formulating fundamental principles of polyvalence and highlighting that different levels of polyvalence exist depending on the range of possible activity rearrangements.[181]

Mihailo Čanak, in his study "Flexibility of Residential Structures as a Factor of the Utility Value of an Apartment," distinguishes between natural and artificial flexibility. Natural flexibility allows residential structures to adapt to different family structures without any spatial changes.[182] This concept aligns closely with what Hertzberger later termed "polyvalence."

According to Ljerka Biondić, the essence of a flexible apartment lies in its adaptable nature, allowing changes within its structure while maintaining predefined elements like the primary load-bearing structure and sanitary nodes. The remaining space retains a polyvalent or ambiguously defined character, lacking specific predefined functions in other areas.[183]

De Paris and Lopez view flexibility more broadly as the capacity of space to adapt functionally or structurally to ongoing user changes. They suggest that achieving flexibility can involve organizing residential space

178 Hertzberger, *Lessons for Students in Architecture*, 146.

179 Hertzberger, *Lessons for Students in Architecture*, 147.

180 Leupen, "Polyvalence, a Concept for the Sustainable Dwelling."

181 Leupen, "Polyvalence, a Concept for the Sustainable Dwelling."

182 Čanak, *Fleksibilnost stambenih struktura kao činilac upotrebne vrednosti stana*.

183 Biondić, „Fleksibilni stan."

Table 5 Characteristic interpretations of the term polyvalence in architecture

Polivalence ...	Authors
... implies different modes of using the same space ... adaptability of space to different human needs with minimal physical modifications.	Ring, 2017
... is a pattern that can be used for different purposes without having to change itself.	Hertzbrger, 1991
... it depends on the spatial organization.	Leupen, 2006
... or "natural flexibility" enables the adaptation of residential structures to different family structures without spatial changes.	Čanak, 1973
... is a specific spatial quality, which motivates users to transform the space into a pleasant environment, the transformation of which is decided by the users themselves.	Zhenduo, 2021
... it represents the ability to transform housing and create space for all the different processes that happen simultaneously.	Grbić, 2019

as multifunctional, indeterminate, or polyvalent, depending on the context.[184] Johanna Brinkenberg and Sonja Miettinen also link flexibility and polyvalence, particularly concerning spaces that can adapt without physical alterations. They argue that a strict distinction between polyvalence and flexibility may not offer optimal solutions in practice, advocating instead for a blend of these concepts to address varying needs effectively.[185]

Paula Femenias and Faustine Geromel, in their research on adaptable housing, delineate two strategies for achieving adaptability in residential spaces: a) polyvalence, which they define as the ability of fixed situations to accommodate different functions, and b) flexibility, referring to the capacity of buildings to be arranged differently through physical changes.[186]

Kyung Wook Seo and Chang Sung Kim suggest that rooms arranged in an enfilade, following a linear arrangement, promote polyvalence because activities can occur in any of them due to their interconnected nature.[187]

Feng Zhenduo views polyvalence as a specific spatial quality that inspires users to create a pleasant ambiance by transforming the space according to their preferences, thus empowering users to shape their environment.[188]

These perspectives highlight the authors' focus on exploring the nuanced differences between flexibility and polyvalence, emphasizing the importance of clarifying the characteristics and defining the term polyvalence within the context of architectural adaptability. (Table 5)

Comparing the perspectives outlined above, it becomes evident that polyvalence in architecture refers to a property or a set of characteristics that enable a space or structure to adapt to various human needs and uses with minimal physical modifications.

184 De Paris and Nuno Lopes, "Housing Flexibility Problem: Review of Recent Limitations and Solutions."

185 Brinkenberg and Miettinen, *Home Free Home: A Polyvalent Approach to Housing*.

186 Femenias and Geromel, "Adaptable Housing? A Quantitative Study of Contemporary Apartment Layouts That Have Been Rearranged by End-Users."

187 Seo and Kim, "Interpretable Housing for Freedom of the Body: The Next Generation of Flexible Homes."

188 Zhenduo, *Polyvalent Space: Approach of Polyvalence Design Theory Applied in Centraal Beheer Office*.

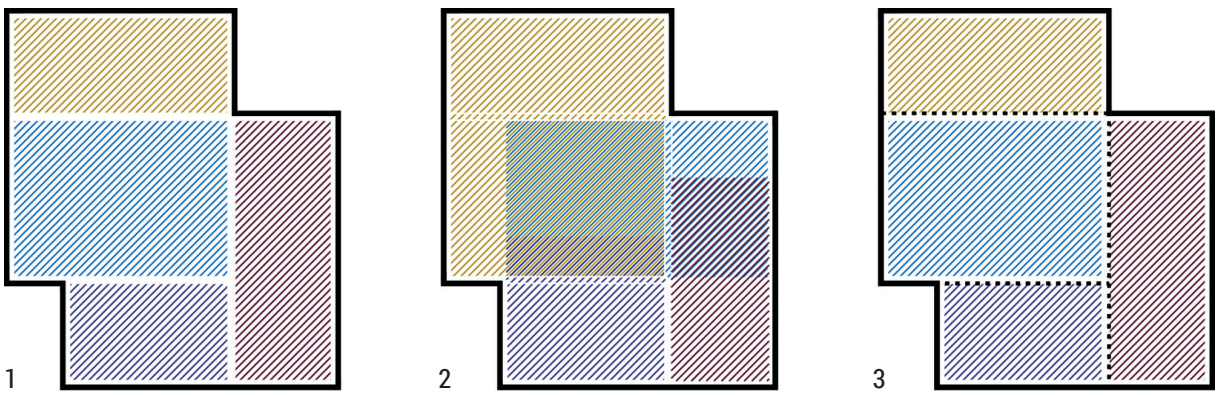
4.4.1. Characteristics of polyvalent space

To qualify as polyvalent, a space must have the physical capability to accommodate multiple functions either concurrently or sequentially, reflecting a degree of similarity to the open plan concept. However, unlike the open plan, which emphasizes the spatial integration of functions,[189] polyvalent space is multifunctional but emphasizes the phased utilization and overlapping of functions. This characteristic offers the potential for substantial optimization of usable area compared to the open plan concept. (Figure 52)

From the presented framework, it becomes evident that the open plan serves as one avenue to realize the principle of spatial polyvalence, while flexibility of space constitutes another method. A space endowed with flexibility can exhibit polyvalence even in the absence of an open plan, and conversely, a space designed with an open plan can embody polyvalence without explicitly incorporating flexibility as a principle. Naturally, there exist polyvalent spaces where both approaches—open plan and flexibility—are seamlessly integrated. However, in theory, *ideal polyvalence* can be attained without necessarily employing these two methods. This implies that occasional function interchange or "pulsing" within the same space, as indirectly suggested by Leupen, could achieve ideal polyvalence. Nonetheless, what are the defining features of polyvalent residences wherein spatial segregation is minimal, or where only specific areas such as bathrooms or toilets are partitioned?

189 Alfirević i Simonović Alfirević, "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."

Figure 52 Comparison of concepts - 1) open plan, 2) polyvalence of space, and 3) spatial flexibility (Source: Authors' drawing)



Open plan	Polyvalence of space	Flexibility of space
multifunctionality	multifunctionality	segregation / multifunctionality
simultaneous use capability	phased use / superposition	simultaneous use capability, phased use / superposition
lack of privacy	absence of privacy, potential privacy	absence of privacy, potential privacy
internal open plan	internal open plan	potential internal open plan openness

By delving into various examples showcasing polyvalence, Bernard Leupen delineates five fundamental principles that underpin polyvalent dwellings:[190]

1) *Room size* – Rooms exceeding 16 m2 possess greater potential to accommodate a range of basic functions effectively;

2) *Number of large spaces* – The presence of multiple large spaces (exceeding 16 m2) within a dwelling enhances the flexibility to allocate basic living functions across different areas;

3) *Basic spatial structure of the dwelling* - Branched and cyclical living space configurations offer a higher degree of polyvalence compared to linear (chain-like) spatial arrangements;

4) *Relationship to spaces with fixed activities (bathroom and kitchen)*;

5) *Spatial relationship type* - Spaces situated at the extremities of a structure exhibit lower polyvalence levels and align more with intimate functions.

From these theoretical insights, it becomes apparent that Leupen's perspective on polyvalence encompasses a broader context, addressing dwellings as intricate spatial and functional entities. However, one aspect that warrants further scrutiny and refinement in his research is the notion that "polyvalence is limited when there is only one large room."[191] Other researchers have delved into the characteristics of polyvalent dwellings as well.[192]

In their study titled "Adaptable Dwelling? A Quantitative Study of Contemporary Housing Rearranged by End Users," Femenias and Geromel outline the following characteristics of polyvalent dwellings:[193]

1) Base with one or more circular connections,

2) Base with a star-shaped arrangement of spaces,

3) Rooms of approximately equal size,

4) Rooms of approximately square shapes and not excessively narrow, and

5) Rooms in series where activities can "overflow" from one to another.

Comparing the concept of "segregated" residential space, where all rooms are distinctly defined physically, with each room corresponding to a single function, to the concept of residential space with an open plan reveals certain similarities and differences. These distinctions can significantly influence the polyvalence of space in a specific manner. (Table 6)

4.4.2. Functionality of polyvalent space

In most residential spaces, certain "remnants" persist when changing the usage regime, referring to unused spaces whose purpose remains undetermined. In "segregated" residential spaces, the physical structure limits the potential for combining functions, leading to a more pronounced presence of unused areas. Conversely, in residential spaces with an open plan, there exists the potential for temporal and spatial overlap of functions, resulting in a higher utility value. For a polyvalent space to be functional, each change

190 Leupen, "The Polyvalent Dwelling."; Leupen, "Polyvalence, a Concept for the Sustainable Dwelling."

191 Leupen, "The Polyvalent Dwelling," 30.

192 Manum, *Apartment Layouts and Domestic Life: The Interior Space and its Usability: A Study of Norwegian Apartments Built in the Period 1930–2005*; Montellano, "Housing Flexibility by Spatial Indeterminacy: The Case of the Casa de las Flores in Madrid."; Yunitsyna, "Universal Space in Dwelling–The Room for All Living Needs." et al.

193 Femenias and Geromel, "Adaptable Housing? A Quantitative Study of Contemporary Apartment Layouts That Have Been Rearranged by End-Users."

Table 6 Similarities and differences that can determine the character of polyvalent housing

Principles	Concept of "segregated" residential space	Residential space with an open plan
Space functionality	Compatibility of functions is not decisive	Compatibility of functions is highly significant
	Privacy is achievable	Lower level or absence of privacy
	Lower usable value - due to the change of functions in the rooms, part of the usable area is not optimally used	Higher level of utility value because of the possibility of superimposing functions and optimizing space
Dimensional predispositions for multifunctionality	Sizes of residential spaces with an area over 16 m²	Size of a space with an area over 22 m² and a minimum width of 3.6m
	Number of large spaces	Possibility of integrating three or more functions in the same space
	Rooms of approximately equal sizes	Room of approximately square or rectangular shape with a side ratio of 1:1.5–1:2
	Rooms of approximately square shapes and not excessively narrow	
Spatial structure	Branched and cyclic schemes provide a higher level of polyvalence than linear ones	Auxiliary spaces grouped together in the center or along the contour of the base
	Rooms in series where activities can "overflow" from one to another	
	Presence of circular connection or enfilade	Presence of circular connection or enfilade
Spatial suggestiveness	Not of particular importance	Highly desirable
Spatial flexibility	Not of particular importance	Highly desirable
Spatial use regime	Simultaneous or phased usage	Simultaneous or phased usage

in function position must achieve compatibility with other functions in a given usage regime.[194] This aspect of organization gains particular significance in spaces with an open plan due to the direct interconnection of functions and the absence of physical barriers. The issue of reduced privacy may arise, especially in open-plan settings, if function changes do not maintain compatibility. This challenge can often be addressed by introducing lightweight flexible barriers such as curtains, screens, or dividers. Similar challenges arise when transitioning between spaces like the living room and bedroom, where quiet and noisy areas may adjoin walls shared with neighbors. The specific organization of polyvalent spaces with an open plan often involves superimposing functions at different intervals, a consequence of the inherent challenge in perfectly fitting functions in a new order to allow for their simultaneous use. It is worth noting that while increased spatial overlaps enhance the space's utility value, they can also reduce comfort due to the need for occasional or constant position adjustments. (Figure 53)

194 Čanak, „Otvoren ili zatvoren stan."

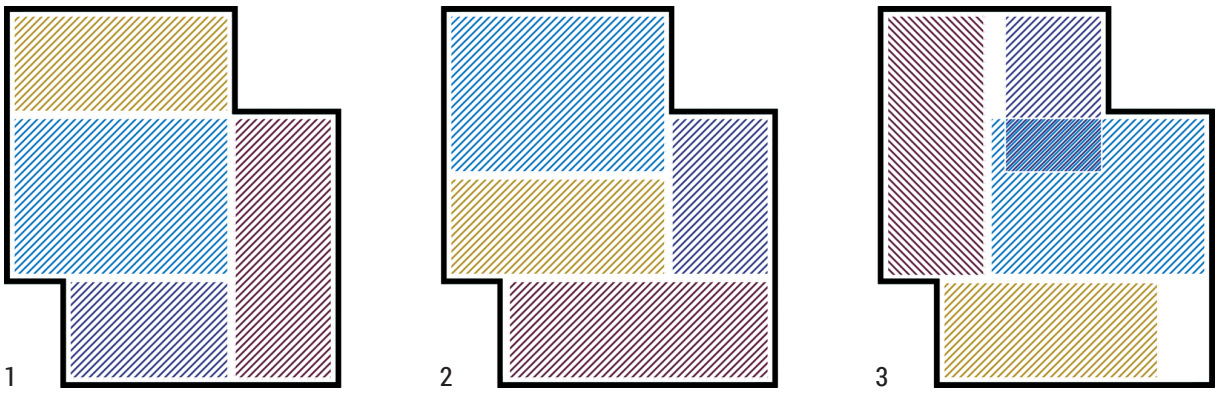


Figure 53 Functionality of an open plan apartment: 1) open plan, 2) ideal polyvalence of space, and 3) polyvalence with superimposed functions and unused spaces (Source: Authors' drawing)

4.4.3. Dimensional predispositions for multifunctionality

One of the most important parameters determining the polyvalence of a space is its inherent capacity for multifunctionality, specifically referring to the dimensions and proportions that enable the simultaneous or phased execution of various activities within that space.[195] In the context of a polyvalent residential space with an open plan, it becomes essential for its boundaries to be defined by dimensions optimal for conducting activities effectively. This means that the space should allow for the combination of at least two residential functions (such as B+C, D+E) in terms of width (A) or depth of the room (F), thus creating flexibility in changing their positions within the same space. (Figure 54)

The dimensions of residential functions are influenced by various factors, which are extensively covered in existing research studies. This work will focus on referencing Mihailo Čanak's research, highlighting the minimum linear dimensions critical for basic room functionalities: 1) a single-line kitchen requires a width of at least 160cm, 2) a double-line kitchen necessitates a width of at least 210cm, 3) a dining room typically requires a width of 200cm, 4) sanitary spaces like toilets need a width of 80cm, while bathrooms require 160cm, 5) a room accommodating a double bed should have a width of 260cm, 6) a room with two separate beds usually needs a width of 240cm, 7) a room with a single bed typically requires a width of 190cm. All these dimensions represent absolute or critical minimums below which residential functions cannot function normally, and therefore, the usability of the living space cannot be discussed.[196] In the context of a residential space with an open plan, the minimum width for normal usage is around 360cm (considering the width of a single-line kitchen and dining room,

195 Brinkenberg and Miettinen, *Home Free Home: A Polyvalent Approach to Housing.*

196 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*; Čanak, „Formiranje sistema vrednovanja upotrebne vrednosti stana."; Čanak, *Svi moji stanovi*; Alfirević i Simonović Alfirević, "Polyvalence of an Open Plan Apartment – Characteristics and Spatial Organization Principles."

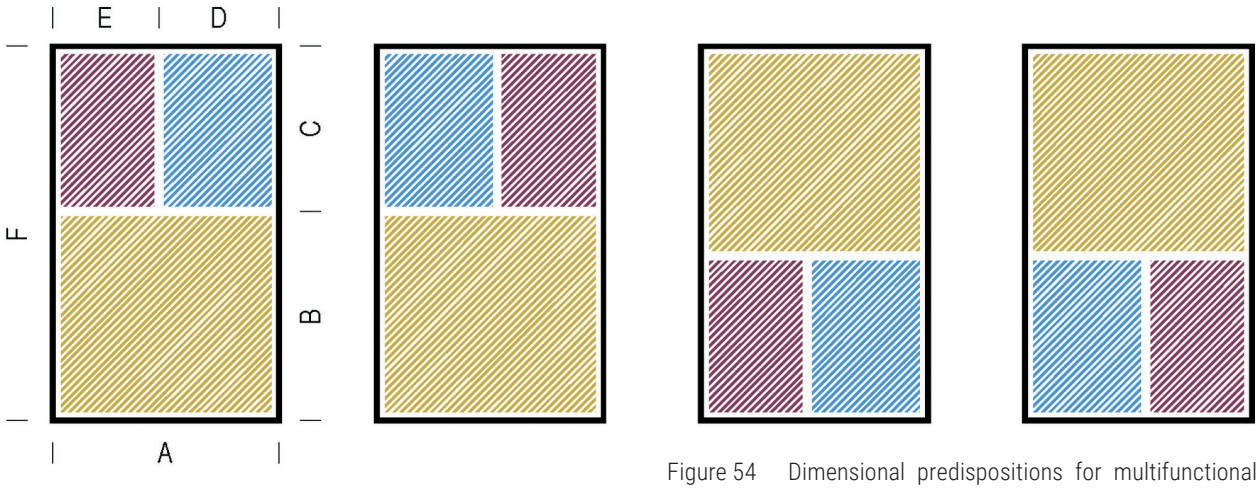


Figure 54 Dimensional predispositions for multifunctional space (Source: Authors' drawing)

i.e., the width of the living room). Additionally, the minimum depth for normal usage in such spaces is approximately 5m, resulting in an aspect ratio of around 1:1.5 to 1:2. Architectural practice may explore more extreme solutions with narrower proportions and smaller dimensions, which can be interesting from an organizational perspective but may compromise comfort and usability.

4.4.4. Structure of polyvalent spaces

The structure of a versatile residential space with an open plan is typically determined by four criteria: 1) the lifestyle and habits of the residents, 2) the health and age status, 3) the concept and arrangement of load-bearing structures, and 4) the family structure and lifestyle organization in the living space.[197] User needs and the possibilities of grouping, i.e., the compatibility of residential functions, are the primary and most common reasons for the emergence of internal plan openness. User needs and the potential for grouping functions, ensuring their compatibility, are the primary reasons for adopting an open-plan interior layout. According to Mihailo Čanak, four fundamental spatial relationships can be observed between residential functions: 1) functions can be performed in the same space, 2) functions that can be performed together but don't necessarily require the same space, 3) functions that can share the same space under specific conditions, and 4) functions that cannot coexist in the same space. It is imperative to physically and visually separate "highly intolerant" and "moderately intolerant" functions from others within the residential space to create a high-quality living environment. Functions categorized as "tolerant" are more flexible in terms of space requirements, allowing them to be integrated into versatile open plan spaces.[198] Different levels of spatial integration can be achieved based on these principles, which will be elaborated upon in the forthcoming chapter titled "Open Plan."

Different combinations of residential functions within an open plan often highlight and emphasize certain areas such as the living room, kitchen, dining area, or lounge, serving as central gathering points around which other functions are organized. These spaces are

197 Alfirević i Simonović Alfirević, "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."

198 Čanak, „Otvoren ili zatvoren stan."

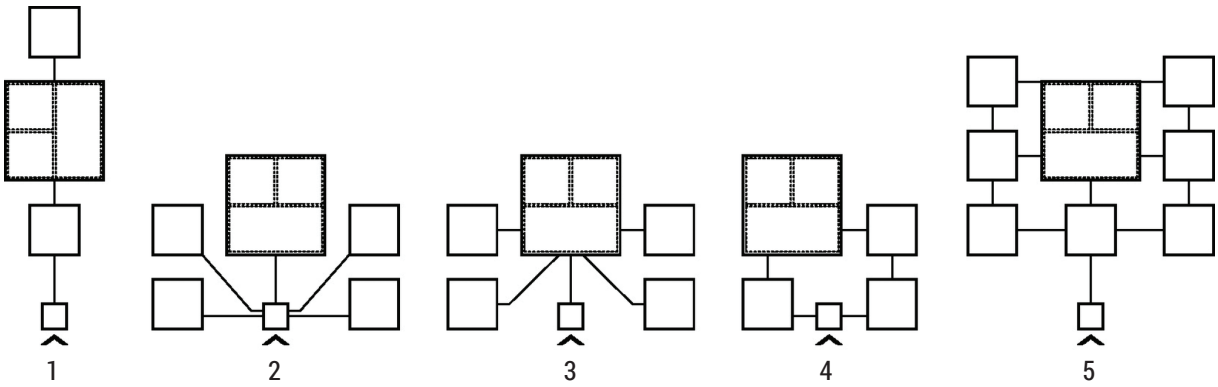


Figure 55 Structural schemes of polyvalent spaces with an open plan: 1) chain model, 2) star model, 3) star model with a central room, 4) circular model and 5) grid model (Source: Authors' drawing)

closely interconnected with workspaces, entry areas, corridors, bedrooms, and less frequently, bathrooms. In his research, Bernard Leupen identifies several characteristic models of structures found in versatile residential spaces: 1) chain model, 2) star model, 3) star model with a central room, 4) circular model, and 5) grid model.[199] Each of these models can be integrated into the concept of an open plan, as they are commonly present in varying segments of residential space. However, in the case of the all-in-one-space concept, where all residential functions coexist within a single area, the structure is ephemeral due to the absence of spatial differentiation. (Figure 55)

4.4.5. Suggestiveness of polyvalent space

Comparing polyvalent space with "generic space",[200] Herman Herzberger emphasizes suggestiveness as a crucial characteristic of versatile space, which he labels differently as "inviting form."[201] The type of polyvalent space, its complexity, internal openness, or continuity, more distinctly suggests various usage possibilities to the user, unlike generic space, which has a more regular shape and therefore offers significantly fewer alternative uses but is less suggestive to the user. According to Herzberger, the difference between multi-purpose and polyvalent space lies in the fact that in multi-purpose design, everything is tendentiously designed to fit various predefined situations, while polyvalence is characterized by not predetermining how the shape or space will function in undefined situations. However, it is debatable whether every user is equally creative in recognizing space characteristics and alternative usage possibilities. What may pose a problem for one user, such as irregular contours of space, a shaded niche, or lower ceiling height, may be seen as potential for qualitative or necessary change by another.

199 Leupen, "Polyvalence, a Concept for the Sustainable Dwelling."

200 According to Bernard Leupen, «generic space» exists within a framework, can be regarded as general, and its use is indefinite. (Leupen, "The Frame and the Generic Space: A New Way of Looking to Flexibility.")

201 Hertzberger, "Polyvalence: The Competence of Form and Space With Regard to Different Interpretations."

4.4.6. Flexibility of polyvalent space

By definition, polyvalent space can be used in multiple ways, but it does not necessarily require flexibility of space or elements.[202] On the other hand, a flexible space may not inherently be polyvalent because variability in space configuration does not directly determine different usage modes. Therefore, flexibility can be one means to achieve polyvalence, especially in open-plan residential spaces, where issues of incompatibility of integrated functions may arise. However, an aspect that has not been debated so far regarding polyvalence is the question of what is the minimum level of flexibility acceptable for this concept, which can enhance it without detracting from the freshness of Herzberger's original idea of "self-sufficiency" of adaptable space. It seems that the answer lies in simplicity, accessibility, and ease of installation or replacement of a flexible system. Massive flexible elements such as movable partitions, walls, or sliding doors require significant economic investment and represent a certain level of complication and solution complexity. Thus, they can shift from being aids to becoming significant aspects of the concept. Therefore, when Herzberger mentions the possibility of applying "minimal flexibility" in polyvalent space, he probably refers to elements like curtains, screens, or partitions, whose installation, removal, and repositioning are simpler and accessible to almost everyone.

4.4.7. Regimes of using polyvalent space

Different regimes of use arise in situations where spatial organization cannot meet human needs. When space and furniture allow for adjustments and changes, expressed human needs can be fulfilled either temporarily or permanently. However, in situations where there are no possibilities for changing physical conditions, functional or interpersonal conflicts may arise primarily, along with certain deviations in user behavior over time. Larger apartments that are functionally organized can more easily adapt to changing human needs due to greater combinatory possibilities. Still, their structure changes more frequently than smaller apartments.[203] Polyvalent residential space must respond to numerous changes that occur daily, periodically, or very rarely among users. Therefore, it is necessary to consider certain potential change characteristics and time intervals when designing:

1) Expansion of space for daily activities:
   - Expanding the bed during daytime/nighttime rest,
   - Expanding the workspace in the kitchen for meal preparation,
   - Expanding the study/work desk for children or adults, etc..
2) Expansion of space for occasional activities:
   - Expanding the family dining table during visits and celebrations,
   - Expanding the extra bed for guest accommodation in the absence of a guest room, etc.
3) Utilization of space for occasional activities:
   - Drying laundry on the terrace, balcony, or veranda if there is no laundry service,

202 Brinkenberg and Miettinen, *Home Free Home: A Polyvalent Approach to Housing*.

203 Femenias and Geromel, "Adaptable Housing? A Quantitative Study of Contemporary Apartment Layouts That Have Been Rearranged by End-Users."

- Using space for ironing if there is no laundry service, etc.

4) Occasional or rare relocation of activities:

- Rearranging the parent's and children's rooms due to the child's growth,
- Changing the room's purpose due to a change in the number of occupants,
- Regular maintenance of space while simultaneously occupied,
- Changing furniture and activity positions due to weariness from long-term use, etc.

A polyvalent residential space with segregated rooms can typically address the need to move activities from one room to another if they are adequately dimensioned, as previously mentioned. However, changes requiring occasional space expansion are characteristic of open-plan polyvalent dwellings, as they offer greater potential for "pulsing" functions.

4.4.8. Characteristic examples of polyvalent residential space

Numerous examples of polyvalent residential spaces exist, some of which have been extensively discussed in scholarly literature. Herman Hertzberger references his houses to illustrate theoretical perspectives, with the Dajagun housing in Delft being a notable early example where polyvalence is evident. This pertains to spaces with comparable dimensional and formal characteristics that offer versatility in use based on users' requirements.[204] While this example includes an open plan, it is worth noting that Hertzberger's primary focus is not on the open plan aspect. (Figure 56)

Bernard Leupen mentions several residential complexes in his essays where the concept of polyvalent spatial organization is evident: the Dapperbuurt district

204 Hertzberger, "Polyvalence: The Competence of Form and Space With Regard to Different Interpretations."

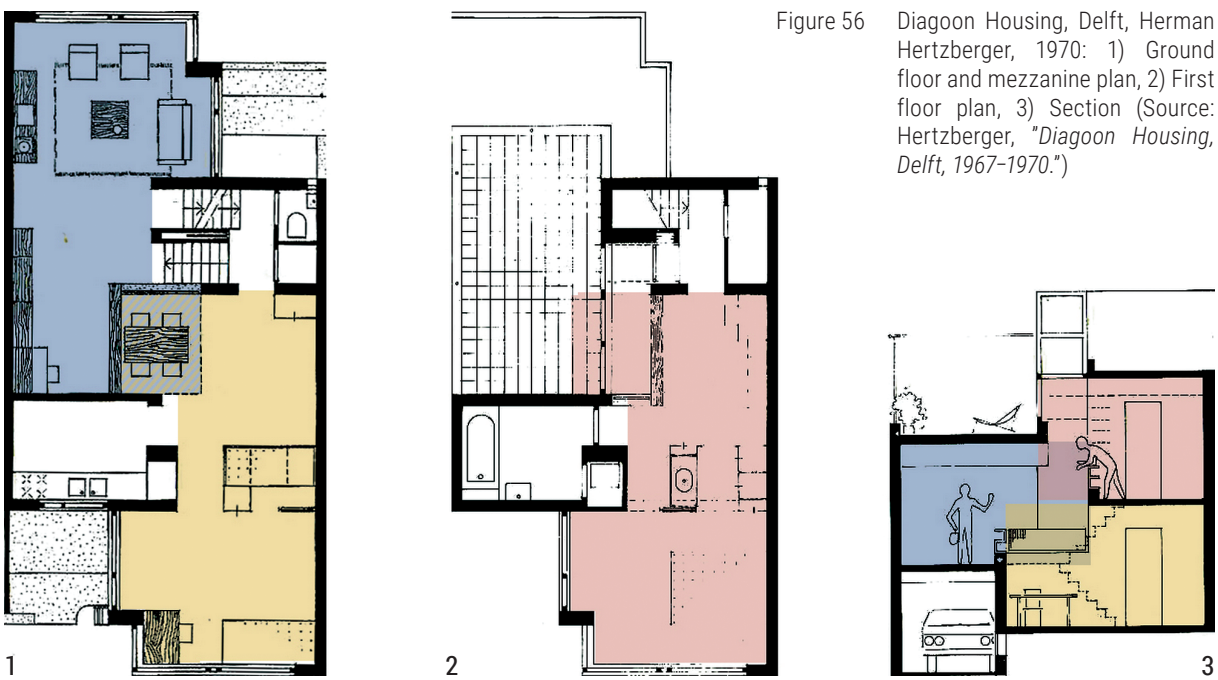


Figure 56 Diagoon Housing, Delft, Herman Hertzberger, 1970: 1) Ground floor and mezzanine plan, 2) First floor plan, 3) Section (Source: Hertzberger, *"Diagoon Housing, Delft, 1967–1970."*)

(Amsterdam, Duinker & Van der Torre, 1986), Patio Island (Ypenburg, MVRDV, 2005), Java Island housing (Amsterdam, Diener & Diener Architekten, 2001), and Bahnhofstrasse Housing (Graz, Riegler & Riewe, 1994).[205] However, in most of these examples, polyvalence is discussed as the potential for replacing functions between spaces, except for the Dapperbuurt complex. In the Dapperbuurt complex, an open plan and cyclic connection of spaces with a circular arrangement are applied, allowing for the interchange of places and expansion of activities. (Figure 57)

In the design proposal for Polyvalent Housing (Russia, AKVS, 2019), architects from the AKVS studio introduce a glazed loggia, sized like a spacious room, positioned in the apartment's center. Rather than solid walls, it consists of lightweight, movable partitions and links to two or more distinct rooms, extending as their annex or acting as a connecting zone when opening up the space fully is necessary. Moreover, the loggia is adaptable and can function as a separate room as required. While this apartment incorporates flexible elements, it demonstrates that polyvalence can be achieved even without their displacement. (Figure 58)

The Polyvalent "Curtain Wall Apartment" (Belgrade, Studio Alfirević, 2019) is designed around an open-plan concept and can adapt its spatial layout. The configuration of spaces is altered by shifting curtains and sliding partitions, resulting in distinct spatial zones. Residential functions are organized within two elongated parallel blocks. When all partitions are closed, it generates a "zero" space of maximum dimensions (600 x 960 cm), while opening them leads to various usage scenarios, ranging from socializing areas, entertainment spaces, and guest reception zones to everyday family

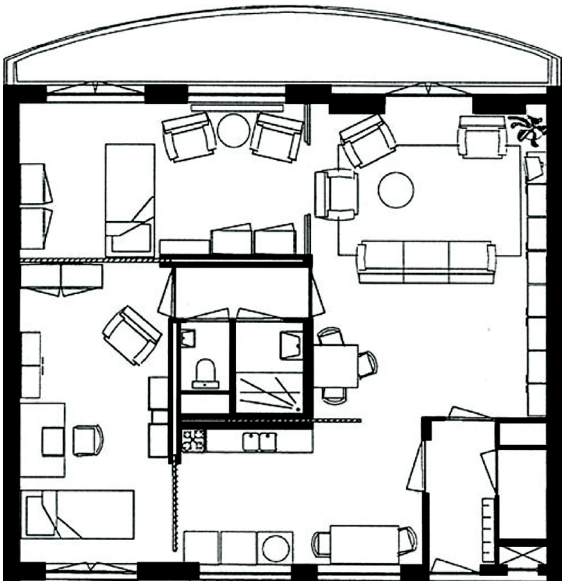
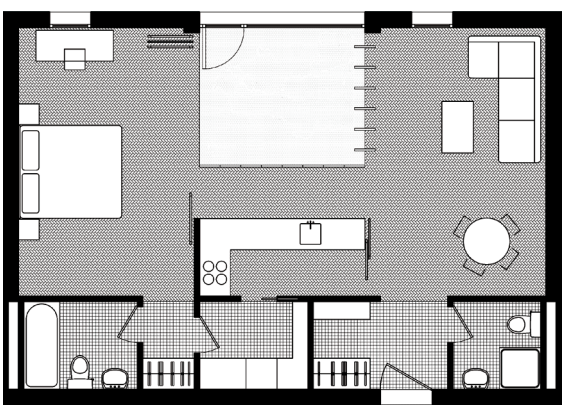


Figure 57 Dapperbuurt district, Amsterdam (Duinker & Van der Torre, 1986) (Source: Leupen, "Polyvalence, a Concept for the Sustainable Dwelling.")

Figure 58 Polyvalent Housing, Russia, AKVS, 2019 (Source: Grbić, "Polyvalence: A Possible Way in Reprogramming Housing Architecture.")



205 Leupen, "Polyvalence, a Concept for the Sustainable Dwelling."

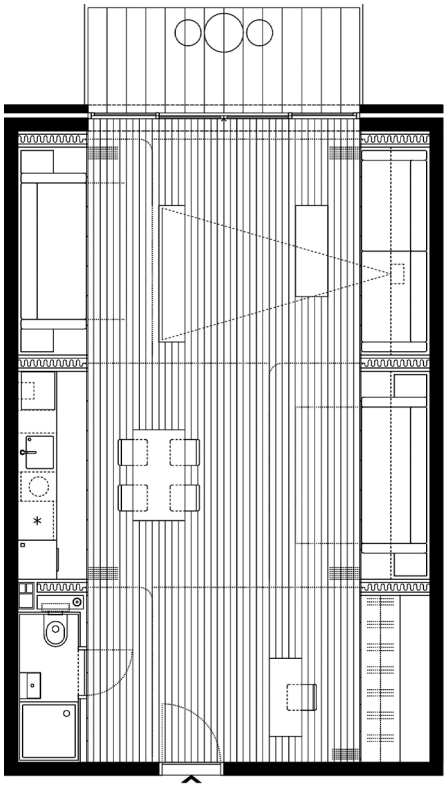
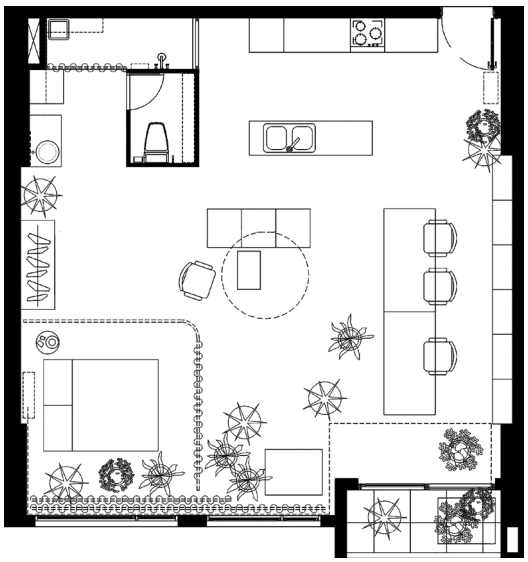


Figure 59 Curtain Wall Apartment, Belgrade, Studio Alfirević, 2019 (Source: www.alfirevic.com)

Figure 60 Rivaparc Apartment Renovation, Vietnam (Nhabe Scholae, 2018) (Source: www.archdaily.com)

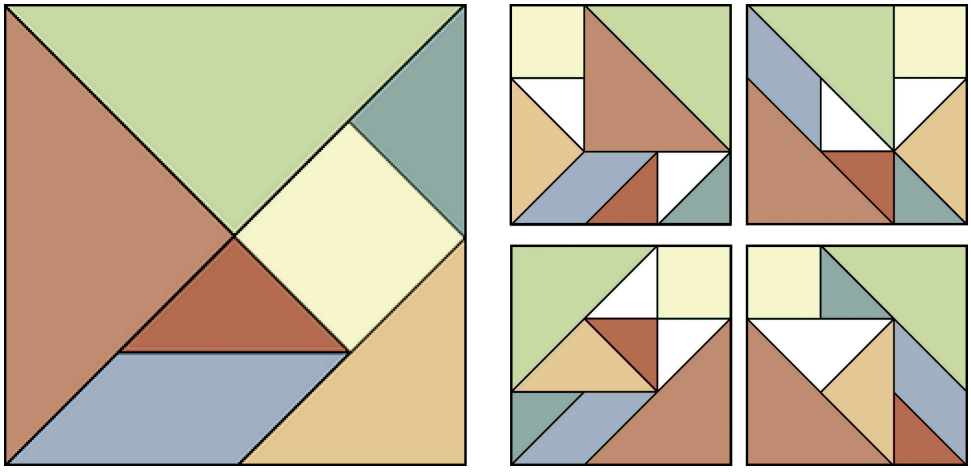


activities during both daytime and nighttime. Similar to the prior example, spatial versatility is achieved without physically relocating flexible elements. (Figure 59)

The Rivaparc Apartment Renovation (Vietnam, Nhabe Scholae, 2018) follows a simplified chain structure principle, aiming for versatility within an all-in-one space, with the exception of the sanitary zone (toilet and shower cabin). The layout allows for flexible organization, enabling functions to be rearranged as required. Flexible elements, like curtains, are strategically used in limited areas to visually partition space for sleeping and the shower cabin. (Figure 60)

Numerous other examples of open-plan residential spaces have been designed following similar principles, where versatility is achieved through minimal flexibility: Alphonse Apartment Renovation, Paris (Match bureau d'architecture, 2019), Nagi Apartment, Yokohama Shi (UUfie, 2009), Pavilion House, Guimarães, Portugal (Andreia Garcia Architectural Affairs, Diogo Aguiar Studio, 2019), PURE, Lisbon (Sílvia Rocio, Mariana Póvoa, Esse studio, 2016), Treetop House, Portugal (João Marques Franco, 2020), and others. In all these examples, the potential for expansion, known as "pulsating" activities, is a notable difference compared to "segregated" polyvalent spaces.

Drawing a parallel between the polyvalent organization of a home and the ancient Chinese puzzle, "tangram," reveals certain similarities. Within a clearly defined outline (representing the boundary of the living space), a limited number of different parts (representing living functions) are arranged to seek an optimal layout without leftovers. While there is typically only one ideal solution within the outline, there exist numerous incomplete variations that result in remnants, akin to the variations seen in tangram puzzles. (Figure 61)



1 2

Figure 61 Example of a tangram with a square field: 1) puzzle solution (left), 2) variations with remnants (right) (Source: Authors' drawing)

The reorganization of activities within a polyvalent apartment allows for various residential functions to change positions within its structure, given there are physical (dimensional) predispositions for such alterations. However, this raises the question of whether these alternative positions are optimal from a functional perspective. In other words, does their relocation lead to unused spaces, thereby diminishing the apartment's utility value? If users have absolute freedom to reorganize the apartment, it brings into question whether they will be aware of all potential adaptability possibilities and, importantly, the implications of these changes. Certain alternative solutions may unintentionally sacrifice spatial, acoustic, or other forms of comfort. The architect's task is to thoroughly reconsider all alternative solutions of spatial organization, or at least the majority, and offer users an optimal concept of space organization through the design process.[206] When designing polyvalent spaces, it is crucial to consider potential life situations and anticipate how users might interact with and adapt the space over time.

When comparing the concepts of "segregated" residential space and residential space with an open plan, a significant difference emerges regarding the nature of activity changes. Residential functions can be relocated, activated, expanded, or contracted within their spatial domain. There is a noticeable contrast in the density of overlapping functions, which can occur with or without remnants. Considering all these aspects, a specific parameter can be defined to gauge the character of polyvalence, known as the "polyvalence index" (PI). This index represents the numerical relationship between the surface area utilized for various purposes and the total surface area of the residential space. A higher polyvalence index correlates directly with an increased level of space utility value, indicating the potential extent of residential space utilization.

Applying the principle of polyvalence aims to increase the effective surface area of a space, allowing for various activities to occur within the same area with minimal or no physical alterations to the space

206 Čanak, „Otvoren ili zatvoren stan," 76.

layout and structure. This expansion of space and standardization of rooms contribute to widening the facade front and may increase construction costs, prompting considerations about the practicality of this principle. However, the true value of polyvalence lies not only in the overall apartment but particularly within the functional zones of an open plan or individual rooms, where strategic organization can lead to space optimization, enhanced efficiency, and consequently, a higher level of utility. Polyvalence within apartments featuring an open plan can manifest within the open plan area itself or in the interaction between adjacent spaces and the functional unit within the open plan. It is important to note that polyvalence can be conceptualized not just horizontally but also vertically, especially in duplex (and less commonly triplex) designs, where residential functions can span across different levels.

4.5. Integration of Functions

4.5.1. Flexibility of space

The inclination towards integrating spaces into a unified whole can be traced back to the emergence of the flexibility concept in architecture, originating from the traditional design of Japanese aristocrats' palaces "shinden-zukuri" in the 11th century, which served as a model for the subsequent development of the samurai house "shoin-zukuri" in the 12th century. In both traditional Japanese house types, flexible sliding "fusuma" partitions were utilized, acting as interior walls, along with "shōji" partitions between spaces and the exterior.[207] The use of sliding partitions in traditional Japanese architecture stemmed from the necessity for interior spaces to seamlessly connect and to open fully towards the garden, creating a space suitable for physical and visual "strolling."[208] This concept influenced numerous architects at the start of the 20th century, including Frank Lloyd Wright, Walter Gropius, Gerrit Rietveld, Kathleen Eileen Gray, Charles and Ray Eames, among others, who drew inspiration from Japanese architecture and movable partitions to introduce space flexibility.[209] A pioneering example of modernist design showcasing flexibility is the Schröder House (1924) in Utrecht, designed by Gerrit Rietveld. Here, movable partitions within the all-in-one space freed it from fixed constraints, resulting in a dynamic and adaptable living environment. A similar approach to space organization, seen in the Villa Savoye and Schröder House, was applied in the E.1027 house from 1929 and the Chateaubriand apartment from 1931 in Paris, both designed by Eileen Gray. In these examples, flexible partitions were used to dissolve the boundaries between spaces, enhancing the overall spatial experience.

Since its official introduction into architectural terminology in the early 1950s, the term "flexibility"[210] has been a subject of exploration for numerous researchers

207 Anderson, *Japanese Architectural Values Through Time: Frank Lloyd Wright's Usonian House and the Creation of a Modern Japanese-Usonian Hybrid*.

208 Paskvaloto, *Estetika praznine*. One of the most representative example of traditional Japanese architecture where the principle of space flexibility was applied is the Katsura Imperial Villa (Katsura Rikyū) in Kyoto from the 17th century, designed by architect Kobori Enshū (Tadej, *Stanovanje u Japanu*.).

209 Schneiderman, *Inside Prefab: The Ready-Made Interior*.

210 Walter Gropius is regarded as one of the early architects to articulate his views on flexibility, doing so in 1954 when he stated that "an architect should design a building not as a monument, but as a shell for the life it accommodates. His concept should be adaptable enough to establish a base that can absorb the dynamic currents of modern life. (Acharya, *Flexible Architecture for the Dynamic Societies*, 16–17).

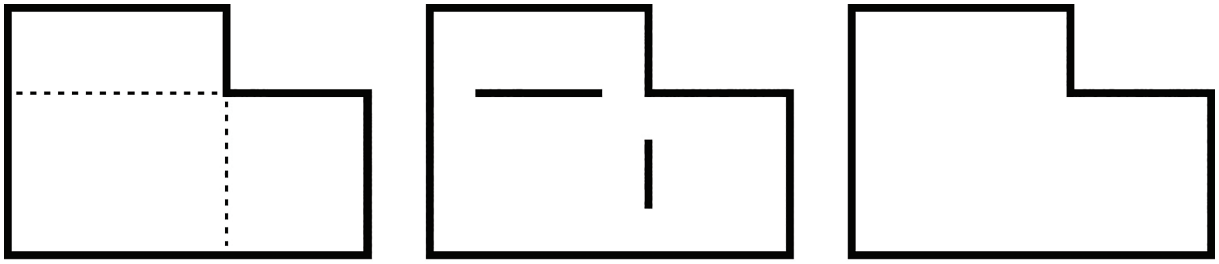


Figure 62 Basic Approaches to Space Integration: 1) Flexible Space, 2) flowing space, and 3) All-in-one space (Source: Authors' drawing)

delving into spatial variability aspects.[211] Most interpretations of flexibility revolve around its potential for occasional spatial change. Specifically, residential spaces that allow for the superposition of functions within their areas, facilitating the removal of movable partitions to establish a flowing or all-in-one space, are often regarded as flexible in a narrow sense. However, the concept of flexibility extends beyond mere spatial adaptability. It encompasses broader notions such as urban variability, as advocated by figures like Yona Friedman, who champions residents' complete freedom to alter their living environments within predefined structures.[212] Similarly, the ideas of metabolists highlight changeable architectural and urban structures capable of adapting and expanding according to users' needs. This expansive understanding of flexibility has significantly influenced the development of other architectural principles, including flowing space and all-in-one space, reflecting a dynamic evolution in design philosophies. (Figure 62)

4.5.2. Openness of space

There are generally two types of spatial openness in residential design: "internal" and "external." Internal openness can be categorized based on its extent as follows: 1) total openness, 2) sectoral openness, 3) partial openness, 4) controlled openness, 5) potential openness, or 6) non-existent openness.[213] The need for internal or external integration of space can arise from various factors. External openness of residential space often depends on: 1) natural influences, 2) built environment influences, and 3) social influences. Internal openness, on the other hand, is influenced by factors such as: 1) residents' lifestyle and habits, 2) their health and age status, 3) the concept and arrangement of primary load-bearing structures, 4) family structure and organization of life in the apartment, and so on. (Table 7).

The emergence of various types of internal openness in spaces can be attributed, according to Čanak, to the compatibility or mismatch of individual residential functions.[214] Some functions can coexist harmoniously in the same space without interference, while others necessitate physical, visual, acoustic, or olfactory isolation to function effectively within the overall

211 Biondić, „Fleksibilni stan."; Čanak, „Otvoren ili zatvoren stan."; Kubet, Carić and Hiel, „Fleksibilnost stambene jedinice u odnosu na grupisanje instalacija."; Acharya, *Flexible Architecture for the Dynamic Societies*; etc.

212 Friedman, "Architecture Mobile."

213 Čanak, „Otvoren ili zatvoren stan."

214 See Chapter 3.1. – Compatibility of functions.

Table 7 Motives for the emergence of internal and external openness in residential space

External Spatial Openness	Internal Spatial Openness
1) Natural influences: - orientation of residential spaces towards natural motifs and vistas in the environment, - orientation of residential spaces opposite to the direction of strong and dominant winds, - orientation of residential spaces towards the south (in northern countries), - blocking sunlit sides of residential spaces (in tropical regions), etc. 2) Influences of the built environment: - orientation of residential spaces away from sources of loud noise, - orientation of residential spaces away from sources of visual, acoustic, olfactory, and other disturbances in densely populated areas, etc. 3) Social influences: - orientation towards internal courtyards and atriums in areas of potential social unrest, - orientation of residential spaces towards internal courtyards as part of cultural and architectural heritage (Middle East), - orientation of residential spaces towards the environment in stable and peaceful environments (Northern Europe), etc.	1) Lifestyle and habits of residents: - need for space for frequent social contacts with extended family members and friends, - need for presentation and emphasizing status, - need for a more intensive presence of service within residential space, - need for aesthetics and experience of spatial comfort, etc. 2) Health and age status of residents: - need for facilitated manipulation of individuals with special needs, - need for internal peace and sometimes complete isolation from external influences, etc. 3) Concept and arrangement of primary load-bearing structures: - presence of large spans in residential spaces, - presence of a skeletal structural system in residential spaces, - presence of significant level changes in residential spaces, - configuration of residential space, etc. 4) Family structure and organization of life in the apartment: - need for play space in multi-member families with young children, - need for intensified use of the kitchen in families with children or when the mother or father is not working, - need for visual supervision of young children during food preparation, - need for communication with other family members during food preparation, etc.

system. Through an analysis of spatial and temporal interrelationships among residential functions, four fundamental spatial relationships become apparent: 1) functions can be performed in the same space, 2) functions can coexist in the same space but are not obliged to, 3) functions can share the same space under specific conditions, and 4) functions cannot be performed in the same space. Optimizing an all-in-one space is particularly crucial for "highly intolerant" functions (labeled as k) and "moderately intolerant" functions (labeled as f, g, h, i, j). Their physical and visual segregation from other functions within residential space is vital for creating a high-quality open-plan environment. In contrast, "tolerant" functions (labeled as a, b, c, d, e) can be integrated into multifunctional spaces, as their specific location within the space is less critical.[215] With the advancement of technology and society, some intolerant functions merge with tolerant ones, either fully or conditionally. An example is the integration of kitchen processes into all-in-one spaces, depending on

215 Čanak, „Otvoren ili zatvoren stan."

their usage and current needs. It is important to note the cause-and-effect relationship among individual residential functions, often appearing in functional sequences or groups. These relationships influence the feasibility of forming an open plan within residential spaces since seamless functioning often requires close spatial proximity among related functions.

By examining characteristic examples that exhibit a trend toward integrating spaces into a cohesive whole, we can observe multiple levels of plan openness based on space organization and function combination within an apartment. This analysis yields different levels of spatial integration:

1) Integration of two residential functions (LR+DN, LR+KT, KT+DN, LR+WS, DN+WS, KT+WS, EA+DN, H+DN, LR+BD etc.),
2) Integration of three residential function (LR+DN+KT, LR+DN+WS, LR+KT+WS, DN+KT+WS etc.),
3) Integration of four residential functions (LR+DN+KT+WS, LR+DN+KT+BD etc.),
4) Integration of multiple residential functions (LR+DN+KT+BD+BT, LR+SA+DN+KT+WS etc.).[216]

From the examples mentioned earlier, it is clear that certain combinations of residential functions are more common and central, such as the living room, kitchen, dining area, or salon. These spaces act as focal points around which other functions are organized, creating close interconnections. They can be termed "generative functions" because they influence the layout and character of all-in-one spaces. For example, all-in-one spaces can be designed around the living room or another generative function like the dining area. This concept was notably relevant in Serbia during the interwar period, seen in examples of the "Belgrade apartment."[217] The reasons behind why a specific function becomes generative are influenced by various factors, primarily the frequency and intensity of use within the space.

4.5.2.1. Open plan

The exploration of open-plan residential space in theoretical terms has been relatively limited, despite its widespread application in architectural practice. Taking a chronological approach to the evolution of residential space structure reveals three distinct levels of "openness" within the plan:1)"Closed" plan - where rooms are clearly differentiated as separate spaces, 2) "Semi-open" - characterized by a partial or flexible integration of individual spaces into combined areas, 3)"Open" plan - marked by a strong tendency to unite multiple rooms into a cohesive whole, aiming for an "absolute" all-in-one space.[218] The tendency towards creating an all-in-one space in residential architecture stems from the need to establish an optimal framework for meeting human needs seamlessly and achieving a heightened sense of spatial comfort within the apartment.[219] Analyzing contemporary examples of residential architecture underscores that the preference for the all-in-one concept is more pronounced in smaller-sized apartments.[220] This trend

216 Residential spaces are denoted by the following abbreviations: living room (LR), salon (SA), dining area (DN), kitchen (KT), bedroom (BD), bathroom (BT), workspace (WS), entrance area (EA), hallway (H).

217 Keković, *Stambena arhitektura Niša u pokretu Moderna između dva svetska rata*; Alfirević i Simonović Alfirević, „Beogradski stan."

218 Schoenauer, *6000 Years of Housing*. The term "absolute" all-in-one space has not been clearly defined in scientific literature to date. In the context of this text, it is used to describe the aspiration for maximum integration of spaces into a cohesive whole, where boundaries between individual spaces dissolve, resulting in a multifunctional space.

219 Čanak, „Ljudske potrebe i stambene funkcije."

220 Tomoko, *Total Housing: Alternatives to Urban Sprawl*.

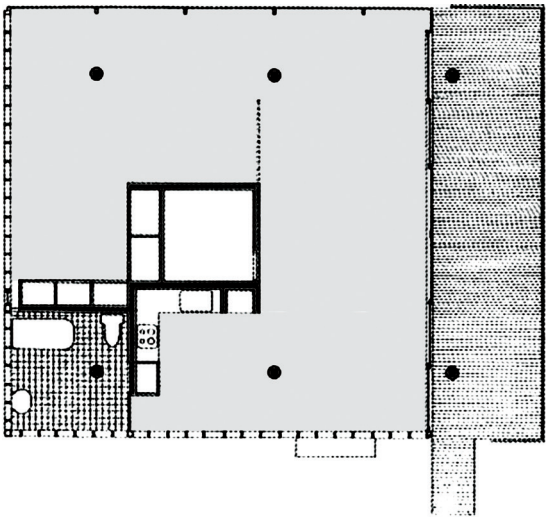
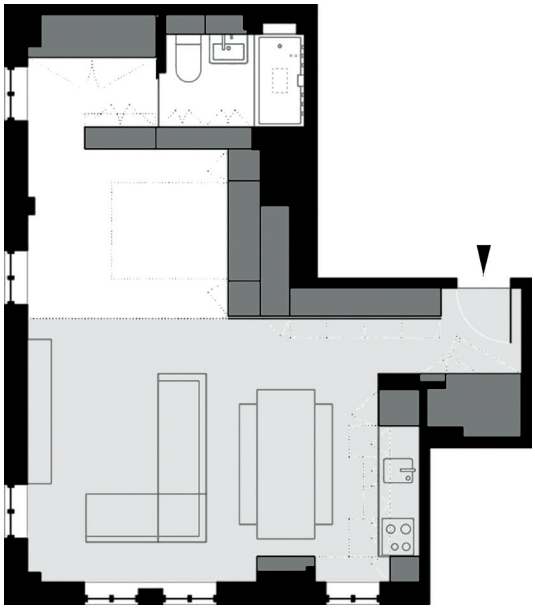


Figure 63 PC Pile House, Shizuoka, Shigeru Ban, 1992 (Source: www.architectmagazine.com)

Figure 64 Transformer Apartment, New York, Studio Garneau Architects & Designers, 2012 (Source: www.inhabitat.com)



is driven by the enhanced feeling of constrained space in compact apartments, where merging residential functions leads to a more efficient and comfortable living and working environment.[221] Conversely, in larger apartments exceeding 20m2 of residential space per person and an area of over 100m2, the significance of integrating spaces diminishes. This is because larger residential spaces inherently provide ample room, reducing the need for extensive integration into combined spaces.[222]

An analytical examination of various designed and realized buildings that have implemented an open plan reveals distinct trends that have become increasingly pronounced since World War II, particularly after the creation of iconic structures such as Philip Johnson's Glass House and Mies van der Rohe's Farnsworth House. These trends shed light on three prominent tendencies in the spatial-functional organization of open plans: 1) the first and most prevalent tendency among architects is the application of established patterns of open plans; 2) the second tendency involves exploring possibilities to achieve an "absolute" all-in-one space, showcasing a desire for seamless integration and flow within the living environment; 3) he third tendency delves into the expressive potentials inherent in an open plan, emphasizing creative and innovative approaches to spatial design that go beyond traditional boundaries.

Analyzing numerous examples of designed and realized buildings where an open plan has been implemented reveals a consistent trend: the combination of two primary residential functions, notably the living room and dining area, remains one of the most frequently employed combinations in contemporary design

221 Čanak, „Otvoren ili zatvoren stan."

222 Biondić, „Stan kao pravo na mjesto."

Figure 65 Interior MA, Moscow, Int2architecture, 2014 (Source: www.int2architecture.ru)

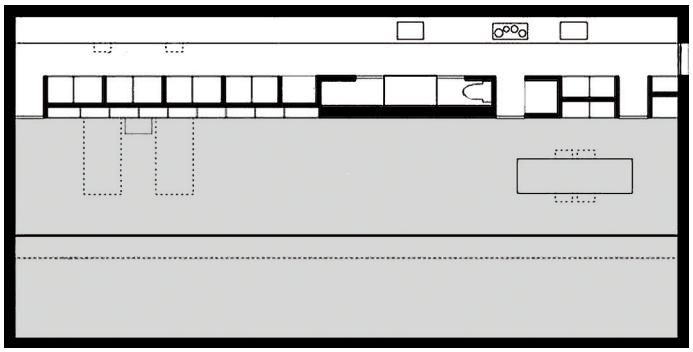


Figure 66 Minimalist House, Okinawa, Shinichi Ogawa, 2009 (Source: www.archdaily.com)

practice. The living room's role as a space for family gatherings and communal activities often prompts designers to integrate it with the dining area, kitchen, workspace, or other residential functions. This integration is particularly common in situations where there is no separate guest reception area within the residential space. In such cases, the living room serves dual purposes, with distinct zones sometimes created to facilitate temporary divisions based on activities (such as hosting guests versus watching television) or different age groups (separating children and adults to prevent interference during activities).[223] When the living room assumes the role of the guest reception area or salon, its furnishing and equipment tend to be more representative than other spaces. The combination of the living room and dining area is prevalent when space constraints make it challenging to provide adequate dimensions for a standalone living space, meeting not just physical but also psychological needs. In these instances where work demands frequent or constant activities within the home, it is common to find a fusion of the living room and workspace, especially if the workspace is not segregated as a separate office or hobby room. However, blending the living room with a bedroom, whether for children or adults, or extending the sleeping area as part of the living space, can prove challenging for larger families. The continuous movement of family members through such integrated spaces can significantly disrupt their functionality, particularly when the living area is actively used. Such arrangements may be more suitable for single individuals or couples, as seen in examples like the PC Pile House (Shizuoka, Shigeru Ban, 1992) (Figure 63), Transformer Apartment (New York, Studio Garneau Architects & Designers, 2012) (Figure 64), Interior MA Apartment (Moscow, Int2architecture, 2014) (Figure 65), Minimalist House (Okinawa, Shinichi Ogawa, 2009) (Figure 66), Tsukiji Room H Apartment (Tokyo, Yuichi Yoshida Architects, 2014) (Figure 67), and others. These designs showcase creative integration of sleeping spaces within combined rooms, offering functionality tailored to smaller household dynamics.

223 Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.

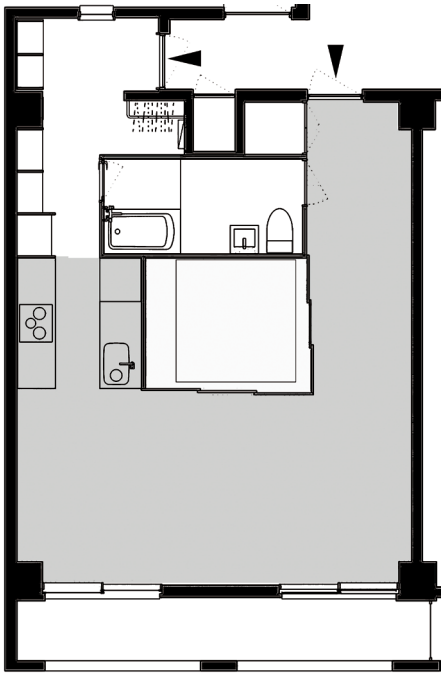
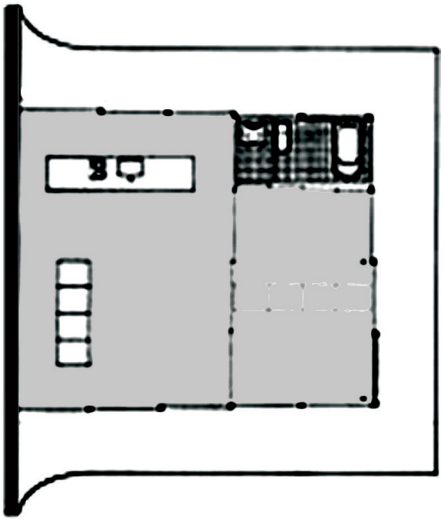


Figure 67 Tsukiji Room H, Tokyo, Yuichi Yoshida Architects, 2014 (Source: www.archdaily.com)

Figure 68 Wall-less House, Nagano, Shigeru Ban, 1997 (Source: www.shigerubanarchitects.com)



When architects venture into extensive integration of residential functions, they often experiment with designs that compromise privacy, blurring the boundaries between different spaces. In some instances, even sanitary facilities are integrated with other residential areas within an all-in-one space. A radical example of this trend is seen in the Wall-less House (Nagano, Shigeru Ban, 1997) (Figure 68) and the Nine Square Grids House (Kanagawa, Shigeru Ban, 1997) (Figure 69), where movable internal walls allow for complete openness of the interior space to the surroundings while still enabling partitioning of sanitary zones as needed.[224] A notable example of this merging of functions is found in the apartments of the residential building CT7165 in Tokyo (AAT & Makoto Yokomizo Architects, 2007), where sanitary spaces are fully integrated into a combined room, creating an "absolute" all-in-one space. Although these are typically studio apartments designed for a single occupant, with or without occasional guests, the extent of function integration in such designs remains a topic of debate.

Exploring the expressive potential of all-in-one spaces in residential architecture represents a distinct direction within the realm of open-plan designs. However, such experiments are relatively uncommon and have often remained conceptual due to the challenges in materialization and execution. Early inklings of this trend can be traced back to visionary projects by Frank Lloyd Wright, such as the Bazett House (1940) in Hillsboro and the Hanna House (1957) in Stanford, along with the visionary sketches and projects of individual expressionists like Hermann Finsterlin and Otto Bartning. A particularly notable

224 Mielnik, "Contemporary Minimalistic Tendencies in Architecture of Single-Family Houses III."

project embodying this ethos is Friedrich Kiesler's Endless House (1950) (Figure 70), where the focus was on finding a natural way to create architecture that is not "corrupted by human will."[225] This concept was further explored by Peter and Alison Smithson in their House of The Future (London, Alison & Peter Smithson, 1956) for the Jubilee Ideal Home Exhibition (Figure 71), which redefined the modernist concept of orthogonal open plans by integrating furniture with interior surfaces, resulting in diverse and continuous spatial experiences.[226] Contributing to this trajectory within architectural experimentation, David Greene of the Archigram group developed prototypes like the Spray Plastic House (1962) and Living Pod (1965) (Figure 72), drawing inspiration from the innovative approaches of the Smithsons. These prototypes featured organically shaped all-in-one spaces devoid of internal walls, reflecting a shift towards more fluid and integrated spatial designs.[227] A pinnacle realization of this organic expressiveness in all-in-one spaces is seen in the Truss Wall House (Tokyo, Kathryn Findlay & Eisaku Ushida, 1993) (Figure 73), which draws inspiration from primitive dwellings like caves and the natural movements of the human body within space, showcasing a harmonious blend of architectural form and human experience.[228]

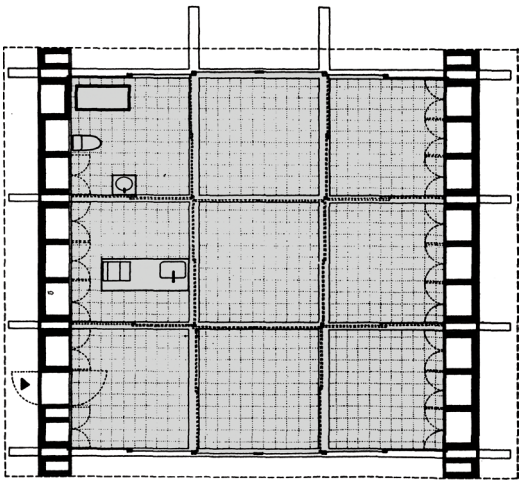


Figure 69 Nine Square Grids House, Kanagawa, Shigeru Ban, 1997 (Source: www.shigerubanarchitects.com)

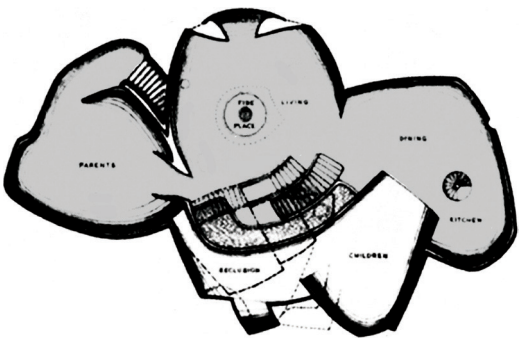
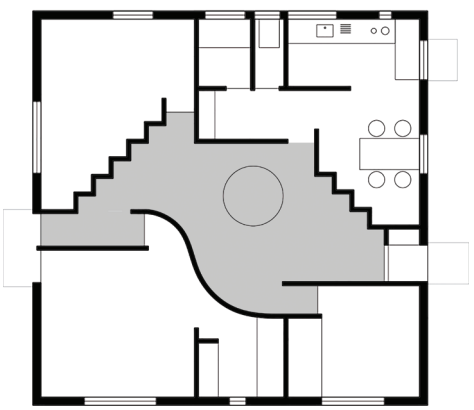


Figure 70 Endless House, Friedrick Kiesler, 1950 (Source: Unwin, *Twenty-Five Buildings Every Architect Should Understand*, 52)

Figure 71 House in Kamiwada, Okazaki (Toyo Ito, 1976) (Source: Authors' archive)



225 Unwin, *Twenty-Five Buildings Every Architect Should Understand*.

226 Hill, "An Other Architect."; Colomina, "Unbreathed Air 1956." The House of The Future was entirely constructed from plastic and was envisioned as a prefabricated product that could be ordered and delivered to a specific address. It did not offer any form of flexible usage but was designed as a singular entity that, akin to other consumer products, could be replaced with a newer model once it became "worn out." (Colomina, "Unbreathed Air 1956.").

227 Zeinstra, "Houses of the Future."

228 Unwin, *Twenty-Five Buildings Every Architect Should Understand*.

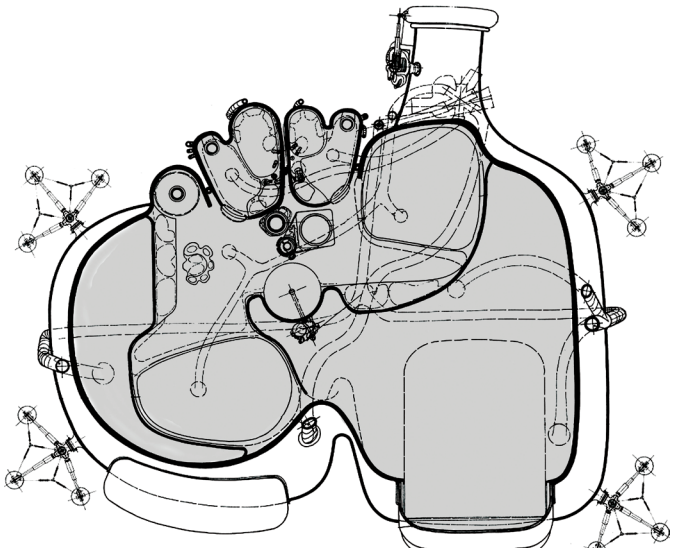
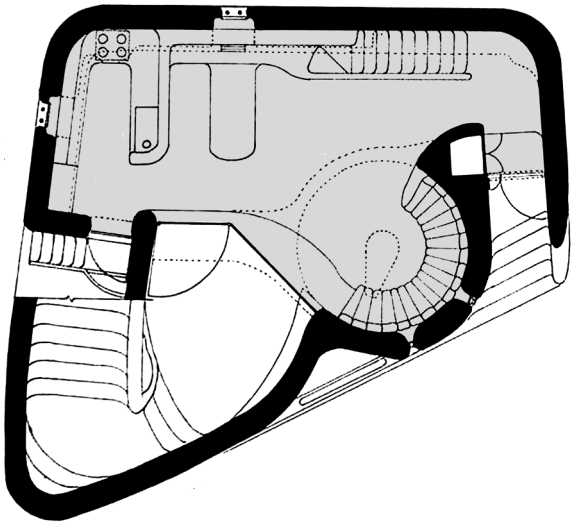


Figure 72 Living Pod, David Greene, Archigram, 1965 (Source: Zeinstra, "Houses of the Future," 216)

Figure 73 Truss Wall House, Tokyo, Kathryn Findlay & Eisaku Ushida, 1993. (Source: Unwin, *Twenty-Five Buildings Every Architect Should Understand*, 45)



4.5.2.2. All-in-one space

The term "all-in-one space" or "open space," in a narrower context, refers to the integration of spaces into a larger whole within architecture and interior design, thereby blurring the boundaries between individual spatial-functional units to varying degrees.[229] When considered broadly, open plans can be categorized into two types: 1) "internal" openness and 2) "external" openness. Internal openness within a building or apartment delineates the degree of integration of smaller spaces and functions into a multi-purpose space of larger dimensions. Conversely, external openness in the plan occurs when there is a rationale for physical and visual connections between internal spaces and their surroundings, achieved through the use of flexible barriers.[230] An extreme manifestation of internal openness is the concept of an "all-in-one space," where fixed or movable barriers are omitted within the spatial framework, allowing the space to be perceived holistically from any viewpoint. According to Peter Ward, the inception of open plans can be traced back to a lesser extent during the second half of the 19th century in the architecture of bungalows in the United States and Canada. These structures commonly integrated the living room and dining room while keeping the kitchen as a separate space.[231] The concept gained wider traction in administrative buildings, notably seen in Frank Lloyd Wright's Larkin Building in Buffalo (1906), showcasing a partial open plan with screen elements instead of solid walls or doors. Wright is hailed as a pivotal figure in advocating for the open plan in residential

229 Alfirević i Simonović Alfirević, "Interpretations of Space Within Space Concept in Contemporary Open-Plan Architecture."

230 Čanak, „Otvoren ili zatvoren stan."

231 Ward, *A History of Domestic Space: Privacy and the Canadian Home*.

architecture.[232] In his projects and realizations around the turn of the century, he emphasized the use of open spaces, which were partially devided by screen-type elements rather than walls or doors, evident in projects like Ullman House (1904) in Illinois and the Robie House in Chicago.[233] However, even in Wright's prairie houses, the kitchen was separate and treated as an independent unit, while the living room and dining room were often organically connected, sometimes along with a library, as in the Darwin-Martin House in Buffalo. Nevertheless, it was during the 1960s that the open plan saw broader implementation worldwide, with kitchens being fully integrated into living and dining areas. This shift was influenced by changes in domestic service dynamics and a reimagining of the kitchen as a central, welcoming space in family life, as noted by Elizabeth Cromley.[234] The open plan concept continued to evolve, notably in Richard Neutra's Lovell House (1929) in Los Angeles, where not only the living room and dining room but also the sleeping area and library were connected as a whole.[235] A defining moment in the development of the open plan concept was marked by the completion of the Glass House (1949) by Philip Johnson in New Canaan, where the living room, dining room, kitchen, workspace, and bedroom were integrated into a unified space, with the bathroom separated as a distinct enclosed block. Shortly after, Mies van der Rohe realized the Farnsworth House (1951) in Plano with a similar concept, laying the foundation for further development of the idea of spatial continuity and providing insights to later architects.[236] An early example of an all-in-one space can be found in the Catalano Residence (1954) in Raleigh, designed by Eduardo Catalano, showcasing interconnected rooms beneath a hyperbolic paraboloid-shaped roof.[237] The rooms below the roof shell, supported by two pillars, are integrated into a cohesive unit where barriers between individual spaces do not reach the ceiling. This design approach evokes a living experience reminiscent of being inside a cave, blurring the boundaries between different areas. The incorporation of such a specific form of all-in-one space has become almost standard in contemporary architectural practice. The precise configuration of this all-in-one space and the range of residential functions it accommodates within the spatial framework largely hinges on the underlying concept of spatial and functional organization.

4.5.2.3. Openness to views in the environment

The organization of space, influenced by the arrangement and alignment of residential areas with natural features in the environment, reflects creators' aspirations to enhance the aesthetic appeal of views from within, either in one direction or multiple directions. This aspiration leads to varying degrees of external openness in the plan. The openness of a plan resulting from this concept can be categorized as follows: 1) *total openness* - encompasses the entire residential space, excluding sanitary facilities; 2) *sectoral openness* - includes only the

232 Alongside Frank Lloyd Wright, early advocates of the open plan frequently cited include architect Henry Hobson Richardson, renowned for works such as the Hay House (1886) and Paine House (1886), as well as the architectural duo Greene & Greene, notable for the Gamble House (1908) in Pasadena (Elliott, "Breaking Down Walls."). In these examples, the open plan involves integrating the living room and dining room into a cohesive space.

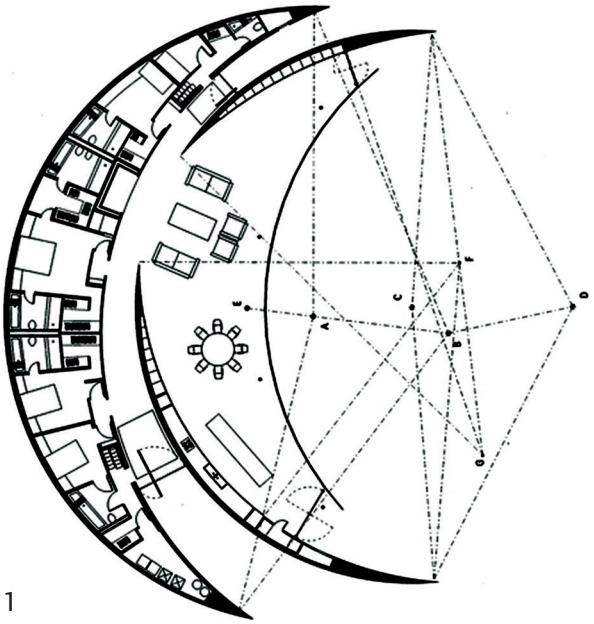
233 Pfeiffer, *Wright*.

234 Cromley, "Domestic Space Transformed, 1850–2000."

235 Elliott, "Breaking Down Walls."

236 Alfirević i Simonović Alfirević, "Interpretations of Space Within Space Concept in Contemporary Open-Plan Architecture."

237 Anonim., "*Why are Pepople Talking About This House? House in Raleigh*."



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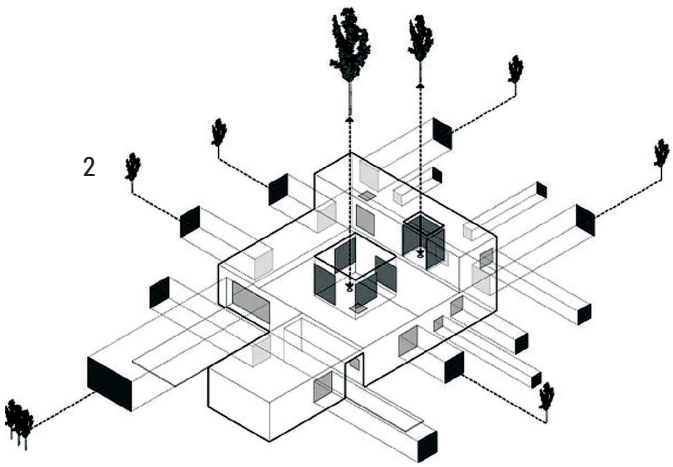


2

Figure 74 The sight motif towards the environment: 1) Crescent House, Winterbrook, Ken Shuttleworth, 2000; 2) Princeton House, Princeton, Levenbetts, 2014 (Source: Authors' archive)

living block; 3) *partial openness* - comprises individual rooms within the apartment, rather than complete blocks; and 4) *controlled openness* - involves the use of flexible barriers to open or close connections as needed.[238] The degree of openness of residential spaces to views in the environment depends not only on the internal spatial layout and the facade's "diffuseness" but also on the nearby spaces' openness, as determined by the *spatial openness index*.[239] Branislava Stojiljković notes that the openness of residential spaces to their surroundings and their interconnectedness significantly influences living quality and comfort. This form of interior openness towards external spaces is termed "space extroversion."[240]

Some of the most notable examples embodying this concept include the Glass House (New Canaan, Philip Johnson, 1949) and the Farnsworth House (Plano, Ludwig Mies van der Rohe, 1951). The natural surroundings surrounding these structures played a crucial role, offering architects the opportunity to achieve a complete plan openness, both internally and externally. A representative example of unidirectional spatial openness towards the environment is the Crescent House (Winterbrook, Ken Shuttleworth, 2000). Here, the curved design of the living block directs all views from the interior towards a picturesque segment of the immediate surroundings. The architectural motif of directed views directly influenced the crescent shape of the residence. Another distinctive example is the

238 Čanak, „Otvoren ili zatvoren stan."

239 The Spatial Openness Index (SOI) represents a spherical segment of the environment's volume that is visible from a specific vantage point in space (Fisher Gewirtzman, "Internal Space Layout and Functionality as a Major Aspect Influencing Visual Analysis.").

240 Stoiljković, *Projektovanje stambenih zgrada: Porodično stanovanje*.

Princeton House (Princeton, Levenbetts, 2014). While its compact primary form might not immediately suggest a focus on views, all window openings are strategically positioned to frame individual segments of the natural environment like artworks within the interior space. This deliberate arrangement underscores the significance of the constitutive motif. (Figure 74)

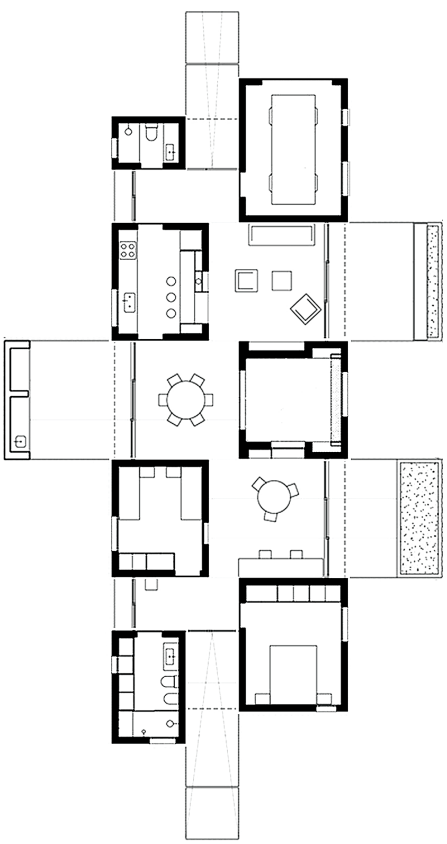
4.5.2.4. Enfilade

In relation to the concept of open plan where spaces and functions are generally grouped into clusters, creating a larger multi-functional space, the "classic" form of enfilade (French: *enfilade*) presents a linear sequence of connected rooms. This design imparts a sense of considerable depth and representativeness of space.[241] An enfilade creates an immersive spatial experience by extending vistas from the entry points through facade openings on both sides, thereby connecting the interior with the surrounding environment. (Figure 75)

The organization of rooms within an enfilade is predominantly axial, featuring a central communication axis. However, there are variations of enfilades with shifted spaces that align with the movement axis. For an enfilade to take shape, direct connectivity between spaces and specific boundaries are essential, often realized through screens that enhance the perspective effect. When attempting to configure spaces irregularly beyond a certain boundary, the enfilade transitions into another spatial concept (such as a circular connection or a flowing space). While an enfilade shares some similarities with an open plan in visually linking smaller spaces, it differs in that the entirety of the space cannot be observed without traversing through it; experiencing

Figure 75 Guna House, Concepcion, Pezo von Ellrichshausen, 2014 (Source: www.archdaily.com)

Figure 76 House Architecture Rifa G'09, Ciudad de la Costa, Maria Ines Garcia & Maximiliano Garcia, 2016 (Source: www.archdaily.com)



241 Etlin, *Symbolic Space: French Enlightenment Architecture and Its Legacy*.

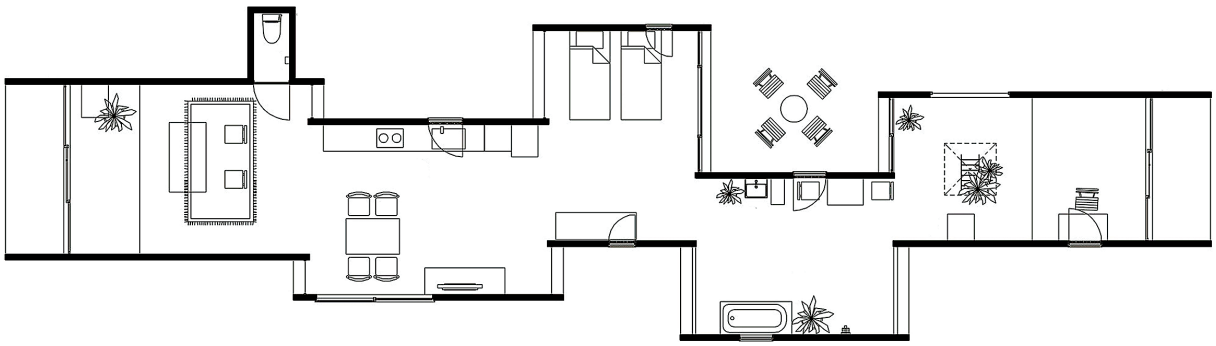


Figure 77 House in Sakura, Sakura, Yamazaki Kentaro Design Workshop, 2014 (Source: www.archdaily.com)

the space in its entirety requires passage through all its sequences.[242] This characteristic introduces a sense of indeterminacy, adding intrigue to the concept from a spatial perspective.

A contemporary illustration of the "classic" enfilade form can be seen in the "Guna House" (Concepcion, Pezo von Ellrichshausen, 2014). The house perimeter hosts a system of linear enfilades, intersecting at right angles. Windows thoughtfully placed at the ends of these vistas cultivate a sense of spaciousness and depth. In recent decades, a more dynamic enfilade style has gained traction, characterized by eccentric movement paths through spaces where both sides engage the movement axis. (Figure 76, 77) This dynamic approach challenges the perception of space boundaries due to its complex and varied proportions resulting from innovative design solutions. Unlike the traditional enfilade layout with screens perpendicular to the movement axis, modern designs often feature enfilades with barriers parallel to the axis, accentuating perspective and spatial depth. An unconventional enfilade variation is exemplified in the "Polyphonic Residence" (Tokoro-gun, Jun Igarashi Architects, 2012). Here, the centrally symmetric enfilade structure is fragmented, creating spatial depth using dematerialized walls or "membranes" that suggest characteristic depths within the elongated space.

4.5.3. Fluidity of space

After the influential Centennial International Exhibition in Philadelphia (1876), where traditional Japanese architecture featuring flexible floor plans and sliding partition walls was first introduced in America, there arose a notable interest in the potential of expanding and harmonizing spaces as demonstrated at the exhibition.[243] This contemplation on flexibility sparked various experiments by architects, aiming to create larger and more cohesive spaces in residential architecture. The realization of architect Frank Lloyd Wright's Meyer-May House (1909) in Michigan and the Robie House (1910) in Chicago marked a significant qualitative shift in residential space organization, introducing the concept of "flowing space."[244] Rather than relying on the conventional method of segregating living areas with solid walls, Wright redefined space boundaries by incorporating

242 Janson and Tigges, *Fundamental Concepts of Architecture: The Vocabulary of Spatial Situations*.

243 Lancaster, "Japanese Buildings in the United States Before 1900: Their Influence Upon American Domestic Architecture."

244 Connors, *The Robie House of Frank Lloyd Wright*; Elliott, "Breaking Down Walls."

wooden screens, curtains, a multitude of glass doors, and extensive windows. Although the spaces were not unified into a compact whole that would clearly define an all-in-one space, thus lacking a stronger impression of continuity and overflowing akin to a circular connection, the concept of flowing space provided a significant impetus for further exploration in habitation studies. One of the most significant realized examples of flowing space is the German Pavilion at the International Architecture Exhibition in Barcelona in 1929, designed by Mies van der Rohe. Although not a residential space, the pavilion profoundly influenced later designers and the adoption of the concept of flowing space. The realization of the German pavilion was preceded by Mies's Brick Country House project (1923), which hinted at the idea of flowing space.[245] Following the great success at the Barcelona Exhibition, Mies laid the conceptual foundations for the application of flowing space in residential architecture through several conceptual projects of atrium houses and with the Hubbe House project (1935) in Magdeburg, Germany.[246] Mies's most significant residential realization applying the concept of flowing space is the Lake Shore Drive Apartments (1951) in Chicago. The space of each of the eight apartments, located on a typical floor, is organized on the principle of flowing space. Here, only the bathrooms are separated as independent units, while the other spaces are integrated into a whole. The sleeping area, although partially enclosed by a shelf acting as a partition, remains part of this integrated space. In his experiments, Mies sometimes pushed intentional functional excesses, such as in the competition project for Berlin in 1931, where he unified living spaces with bedrooms without any doors.[247] Unlike flowing space, where spaces are linearly connected to establish a continuous sequence that can sometimes appear as a circular connection, the concept of all-in-one space primarily involves concentrating space around a residential function as a constitutive motif.

4.5.4. Circular connection

Circular connection is a fundamental concept in organizing residential space, involving the creation of uninterrupted communication within a system of sequentially linked spaces. This approach is commonly used to enhance spatiality, especially in situations with limited square footage, aiming to mitigate the feeling of cramped space. It is also employed in larger spaces to achieve clear differentiation or connection between distant functional zones. While the first historical application of circular connection is not explicitly documented in scientific literature, there are indications of its existence as far back as the Middle Ages, with potential examples even preceding that era. According to Vladimir Lojanica, "circular connection represents one of the most significant advancements in the theoretical and practical exploration of residential organizations."[248] Dušan Ilić further asserts that "the implementation of circular connection in an apartment typically serves two primary purposes: 1) facilitating socio-integrative processes within the family, enabling various forms of communication (visual, auditory, movement) among its members, and 2) addressing the limitations of certain organizational schemes in apartments where the connection of individual spaces (rooms) with the entrance depends on other (usually shared) spaces of the apartment."[249]

245 Russell, *Mies van der Rohe: European Works, Architectural Monographs 11*.

246 Russell, *Mies van der Rohe: European Works, Architectural Monographs 11*.

247 Russell, *Mies van der Rohe: European Works, Architectural Monographs 11*.

248 Lojanica, *Arhitektonska organizacija prostora – stanovanje: Tematske celine*, 201.

249 Ilić, *Projektovanje stambenih zgrada 1: Organizacija stana*, 33.

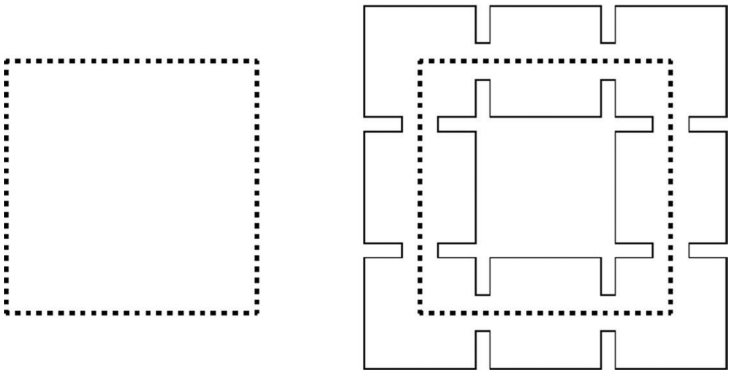


Figure 78 Continuous movement (left) and "circular" connection (right) (Source: Authors' drawing)

Unlike the concept of continuous movement in its general sense, which implies the ability to move unimpeded along either open or closed trajectories, be it in outdoor or indoor spaces, the term "circular connection"[250] in architecture specifically denotes a form of internal communication established within a space. Its primary aim is to create a sense of continuity by linking spaces and thereby minimizing or neutralizing the feeling of cramped space.[251] (Figure 78)

The concept of a circular connection finds notable application in organizing diverse architectural layouts, particularly in residences characterized by limited square footage or complex structures with numerous rooms. In smaller apartments, the circular connection is often employed to create a psychological perception of expanded space.[252] Conversely, in larger spaces, it serves to deepen vistas within the dwelling and achieve visually striking effects reminiscent of baroque enfilades (French: *enfilade*).[253] The circular connection typically extends into additional communication pathways, sometimes leading to the development of intricate systems. Its implementation in residential spaces frequently revolves around a centrally positioned sanitary block, although it can also encircle auxiliary areas such as wardrobes, storage rooms, staircases, and more.[254] Examples where spaces are connected in a continuous system around main residential areas such as the living room, dining room, library, study, etc., are less common. While it's less common, there are instances where spaces are interconnected in a continuous system around primary residential zones like the living room, dining room, library, or study. According to Dragana Mecanov, successful implementation of the circular connection depends on achieving proper spatial grouping; otherwise, conflicts may arise where entry paths intersect with access to individual rooms.[255]

250 In architecture, besides the term 'circular connection,' various other terms are commonly employed, such as 'circulation,' 'circulation route,' 'enclosed circulation,' 'restricted circulation,' 'circular movement,' 'circular motion,' 'circular enfilade,' 'continuous circulation,' 'concentric circulation,' among others. These terms all refer to the same concept, which is the ability for movement to flow freely and uninterrupted along a clearly defined path (Hutchison, "Drawingboard: Lessons in Residential Design – Houses That Flow."; Natapov, et al., "Building Circulation Typology and Space Syntax Predictive Measures.").

251 Živković and Jovanović. "A Method for Evaluating the Degree of Housing Unit Flexibility in Multi-Family Housing."

252 Alfirević i Simonović Alfirević. „Beogradski stan."

253 Seo and Kim, "Interpretable Housing for Freedom of the Body: The Next Generation of Flexible Homes."

254 Bajlon, *Stanovanje: Tema 1 – Organizacija stana*.

255 Mecanov, „Tipologija oblika stambene arhitekture pedesetih godina XX veka u Beogradu."

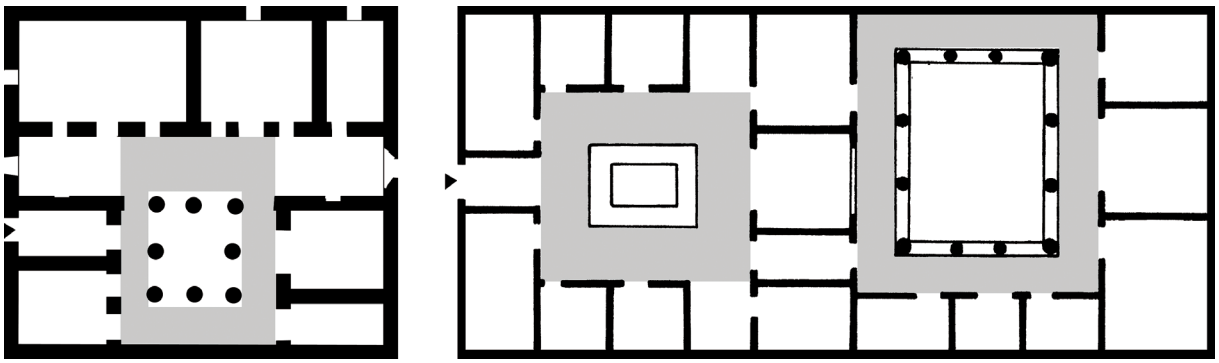


Figure 79 Greek house in Delos (House of Colline, Delos, ~2nd century BCE) (left) and characteristic Roman domus (~1st century BCE) (right) (Source: Authors' drawing)

4.5.4.1. Origin and development of the circular connection concept in residential architecture

So far, there it has not been definitively determined as to when the concept of circular connection first emerged in residential architecture. It is conjectured that circular movement might have been part of ancient cultures, possibly in the context of religious rituals.[256] A distant precursor to the circular connection in residential architecture could be traced back to the Hellenistic house featuring a portico (a covered corridor) encircling a central courtyard. This design served as a template for the subsequent development of the Roman house, known as the *domus*.[257] Both examples showcase continuous communication within the covered area, providing indirect connectivity among peripheral spaces. (Figure 79)

In the early Middle Ages, instances of circular connection in residential architecture were exceedingly uncommon. Continuous movement was mainly observed within the realms of sacred and fortification architecture. Distant precursors of this concept can be found in features like the peristyle surrounding atrium courtyards, commonly known as cloisters, within the residential-administrative segments of monastic complexes such as Citeaux and Fontenay in France, as well as Durham Monastery in England, among others. Moreover, examples of continuous communication can be observed in specific cases of donjon towers, as seen in places like Hedingham Castle, representing early instances of this architectural concept. (Figure 80)

During the 15th and 16th centuries, the concept of "circular connection" emerged in Italian Renaissance palaces through directly interconnected spaces arranged in cyclical sequences. Unlike other residential forms of the era, Renaissance palaces often featured doors that allowed movement between spaces without immediate necessity, thus blurring the boundaries of privacy. Among architecturally renowned examples like the Farnese Palace, Strozzi Palace, Riccardi-Medici Palace, and others, where circular connection was applied selectively, the Piccolomini Palace in Pienza stands out as a complete realization of this concept, designed by architect Bernardo Rossellino in

256 Kehnel and Mence, "Representing Eternity: Circular Movement in the Cloister, Round Dancing, Winding-Staircases and Dancig Angels."

257 Graham, "Origins and Interrelations of the Greek House and the Roman House."

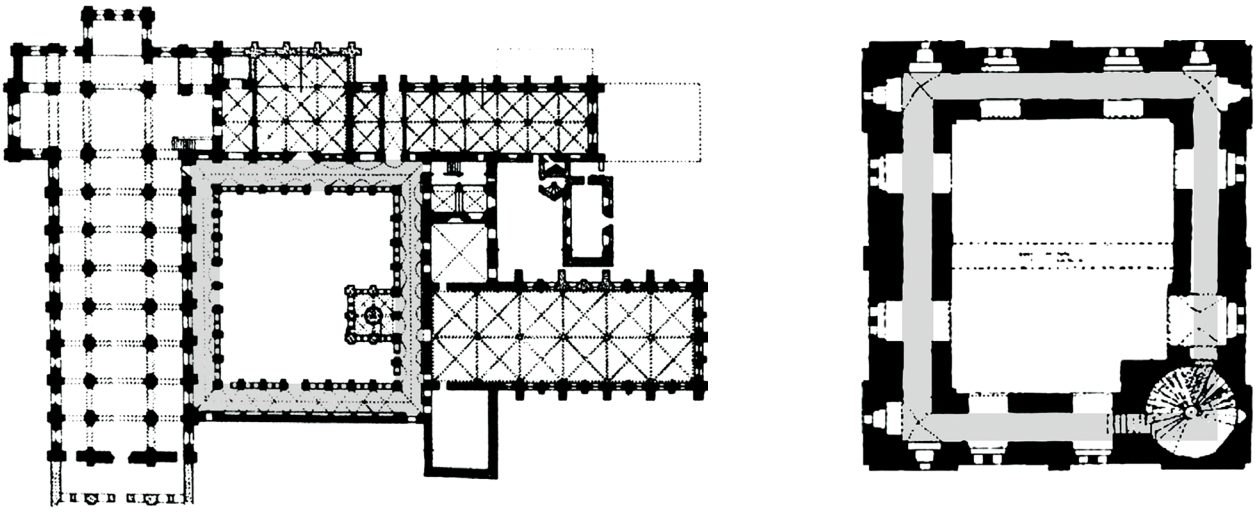


Figure 80 Fontenay Monastery complex in France (left) and the donjon tower of Hedingham Castle in the United Kingdom (right) (Source: Authors' archive)

1459. Another significant example is the famous Villa Rotonda in Vicenza (1571), designed by Rossellino's mentor Andrea Palladio, which, alongside Villa Antonini by the same architect, epitomizes the purest forms of circular connection during the Renaissance period. In all three instances, spaces are interconnected around the house in a cyclical, uninterrupted sequence, with secondary connections within the house based on the same principle in Villa Rotonda and Villa Antonini. (Figure 81) Between 1540 and 1570, Palladio designed numerous villas based on the circular connection principle, including: Villa Cornaro (Piombino Dese, 1552), Villa Pisani (Bagnolo, 1545), Villa Emo (Fanzolo di Vedelago, 1559), Villa Pojana (Pojana Maggiore, 1549), Villa Ragona (Ghizzole di Montegaldella, 1553), Villa Godi (Lonedo di Lugo di Vicenza, 1557), Villa Serego (Santa Sofia di Pedemonte, 1565), Villa Mocenigo (Donegal di Cessalto, 1564), Villa Thiene (Quinto Vicentino, 1550), Villa Zeno (Donegal di Cessalto, 1555), among others.[258]

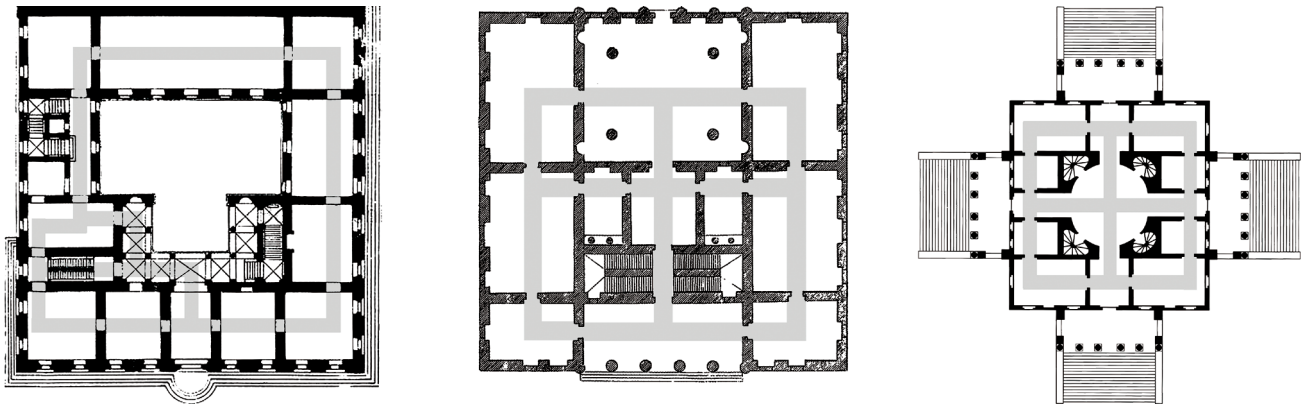
Reflecting on ancient architectural models, the Italian architect and theoretician Leon Battista Alberti, in his treatise "Ten Books on Architecture," emphasizes the strategic placement of doors within a house to facilitate connectivity between multiple rooms.[259] This architectural perspective endured until the emergence of corridors in the late 16th century, marking a significant shift in the functional organization of architectural spaces. The introduction of corridors, serving as dedicated spaces for communication and linking various areas, allowed for an enhancement of privacy by reducing the need for numerous doors between living spaces.[260] Conversely, the integration of corridors facilitated a clearer distinction between service areas and reception/living spaces,[261] a foundational principle that persisted until the early 20th century and continues to influence design to some extent today.

258 Colmenares, "*The Plan of Equivalents. Mat-Rooming.*"

259 Evans, "Translations From Drawing to Building and Other Essays."

260 So far, the exact origin of the corridor in architectural history remains undetermined. However, examples such as the Vasari Corridor in Florence (designed by Giorgio Vasari in 1565) (Jarzombek, "Corridor Spaces.") and Beaufort House in Chelsea (designed by John Thorpe in 1597) (Evans, "Translations From Drawing to Building and Other Essays.") are considered among the earliest examples.

261 Colmenares, "The Plan of Equivalents. Mat-Rooming."; Grikevicius, Reinterpreting of Contemporary Dwelling: What are the Spatial Arrangements for Homes of the Future?



1 2 3

Figure 81 Circular Connection in the Renaissance Period: 1) Piccolomini Palace, Pienza, Bernardo Rossellino, 1459; 2) Villa Antonini, Udine, Andrea Palladio, 1556; and 3) Villa Rotonda, Vicenza, Andrea Palladio, 1571 (Source: Authors' archives)

While corridors became increasingly common in residential architecture during the 16th and 17th centuries, the concept of circular connection persisted, albeit with a shift in emphasis during the Baroque period. Rather than being abandoned, circular connection gained a new aesthetic dimension in residential and palace architecture. This era witnessed the development of enfilades, characterized by long axial sequences of rooms, doors, and windows. This arrangement aimed to create dramatic visual effects and establish a spatial hierarchy, with circular connections often elongated to fit within this new design framework.[262] (Figure 82)

A pivotal shift in spatial organization occurred with the introduction of the open plan concept in the mid-19th century and the development of the flowing space concept at the turn of the 20th century.[263] These innovations signaled a departure from the rigid confines of circular connections, introducing a more fluid and dynamic approach to spatial design. Notably, houses such as the Darwin-Martin House (1903–1905) in Buffalo, the Meyer-May House (1909) in Michigan, and the Robie House (1910) in Chicago, designed by architect Frank Lloyd Wright, marked a significant breakthrough in residential architecture. These designs embraced the concept of "flowing space," a departure from the traditional practice of partitioning spaces with solid walls[264] (Figure 83) Wright's approach involved delineating space boundaries using wooden screens, curtains, extensive glass doors, and windows instead of rigid walls. While these spaces did not form a compact whole characteristic of all-in-one spaces, they conveyed a sense of continuous interconnectedness and flow akin to circular connections. The concept of flowing space catalyzed further exploration and research in housing design, offering new avenues for spatial creativity and functionality.[265]

262 Ching, *Architecture: Form, Space & Order*.

263 Alfirević i Simonović Alfirević. "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."; Alfirević i Simonović Alfirević. "Interpretations of Space Within Space Concept in Contemporary Open-Plan Architecture."

264 Connors, *The Robie House of Frank Lloyd Wright*; Elliott, "Breaking Down Walls."

265 Alfirević i Simonović Alfirević. "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."

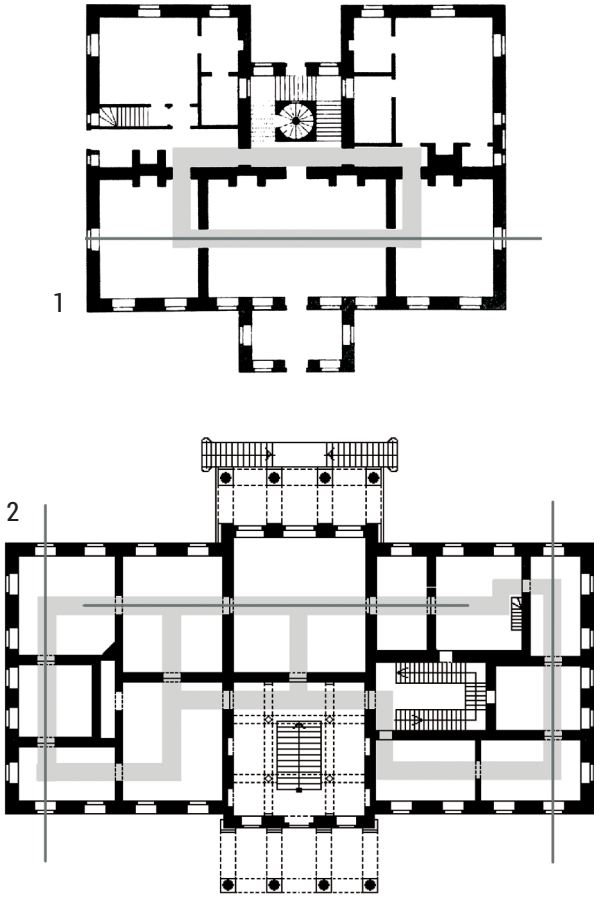


Figure 82 Circular Connection with the Concept of Enfilade and Opening to the Surroundings: 1) Amesbury House, Wiltshire, John Webb, 1664; 2) New Castle, Kostelec nad Orlicí, Heinrich Koch, 1835 (Source: Authors' archive)

Unlike the open plan concept, which aims to integrate spaces into an "all-in-one space" for physical expansion and increased spatial comfort, the circular connection approach primarily focuses on creating a sense of greater spatiality. It also plays a role in enhancing the overall quality of the dwelling by reducing unnecessary communication pathways and optimizing the use of available space for social integration among family members.[266] The combination of circular connection and open plan ideas in the early 20th century influenced the development of the flowing space concept, which incorporates elements from both approaches. These concepts collectively form the foundation of contemporary functional organization in residential spaces.

266 Knežević, *Višestambene zgrade*.

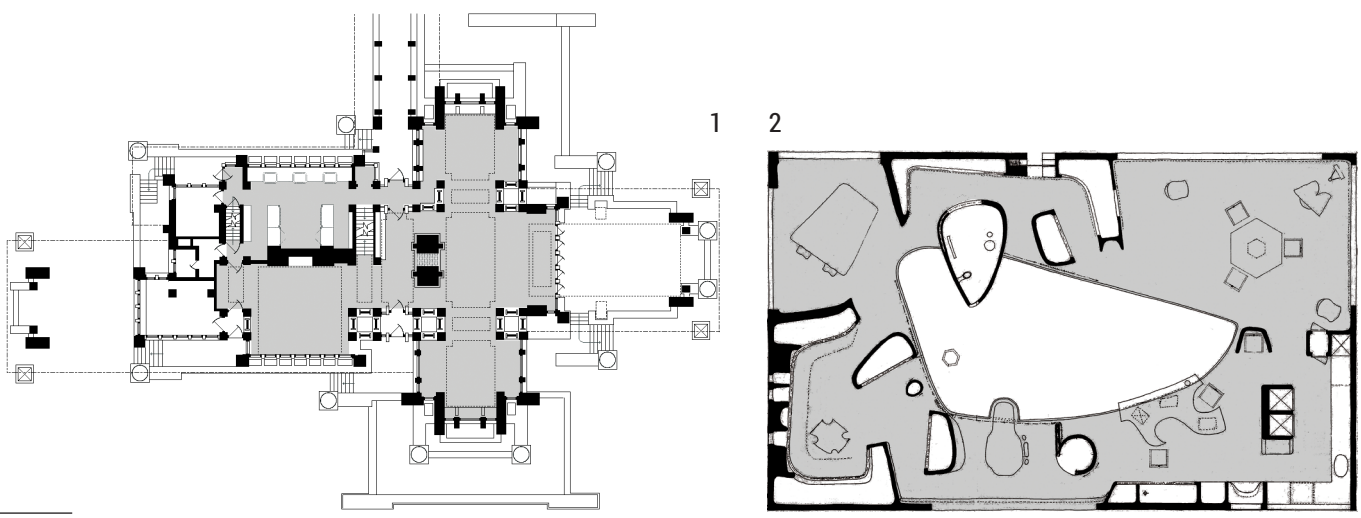


Figure 83 Evolution of circular connection into the concept of flowing space in 1) the Darwin-Martin House (Buffalo, Frank Lloyd Wright, 1903–1905) and 2) House of the Future, London, Alison & Peter Smithson, 1956 (Source: Authors' archive)

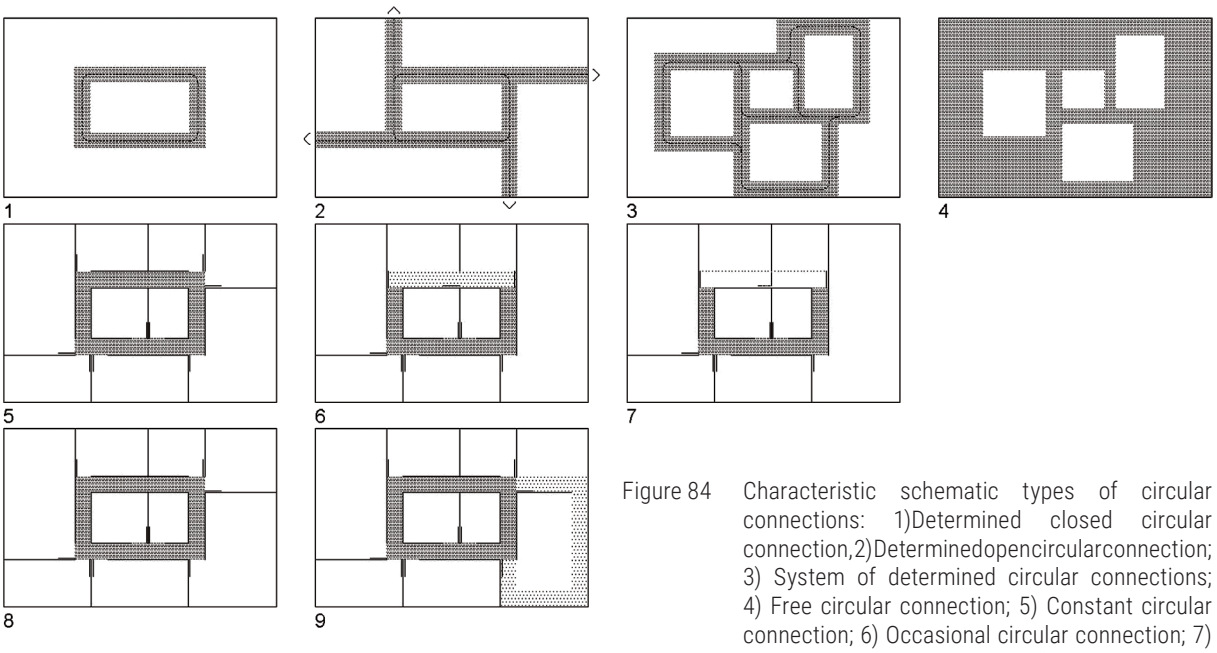


Figure 84 Characteristic schematic types of circular connections: 1)Determined closed circular connection,2)Determinedopencircularconnection; 3) System of determined circular connections; 4) Free circular connection; 5) Constant circular connection; 6) Occasional circular connection; 7) Potential circular connection; 8) Primary circular connection; and 9) Secondary circular connection. (Source: Authors' drawing)

4.5.4.2. Characteristic types of circular connections in residential architecture

After analyzing numerous examples of circular connections throughout architectural history, several characteristic types can be distinguished based on various criteria: (Figure 84)

a) Path character (formal aspect):

- Determined closed circular connection
- Determined open circular connection
- System of determined circular connections
- Free circular connection

b) Persistence/frequency (temporal aspect):

- Constant circular connection
- Occasional circular connection
- Potential circular connection

c) Hierarchy/significance (functional aspect):

- Primary circular connection
- Secondary circular connection

A determined closed circular connection is typically found in medium-sized (~50–100m2) and larger (over 100m2) residential spaces, where the hallway space is distinctly separated from other areas to achieve clear functional differentiation. Communication zones are usually well-defined on all sides, maintaining a consistent width and profile without significant variations in the width-to-height ratio. In smaller residential spaces (up to 50m2), the circular connection is often integrated within interconnected living areas to optimize floor space and enable multifunctional use.[267] Characteristic examples of the determined closed circular connection include the Guna House (Concepcion, 2014) and Parr House (Chiguayante, 2008) by Pezo von Ellrichshausen, where continuous walls delineate space boundaries within which the circular connection is established. Corridors maintain equal widths and heights, with some flexibility

267 Wentiling, *Designing a Place Called Home – Reordering the Suburbs*.

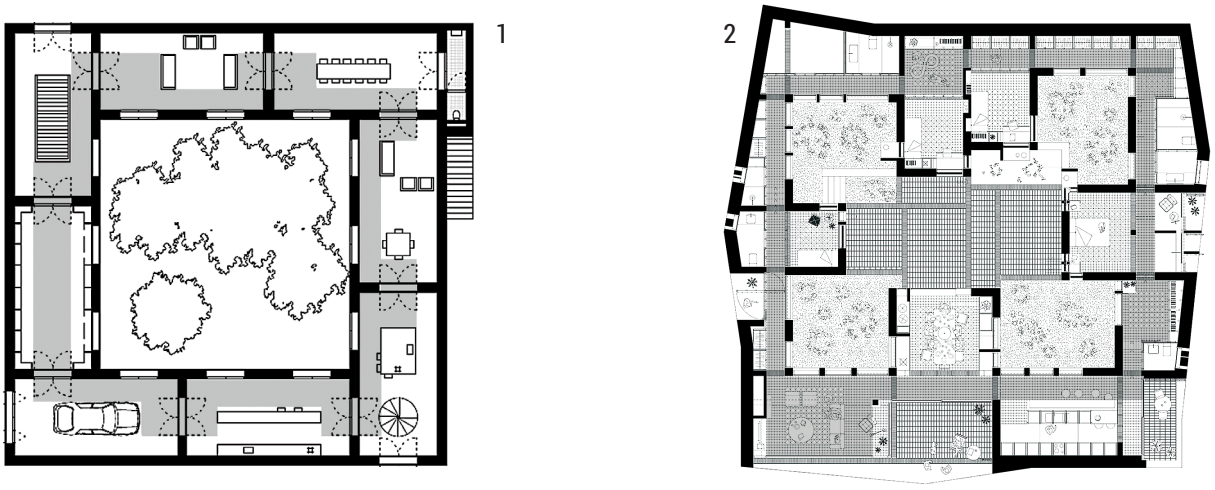


Figure 85 Determined closed circular connection: 1) 25 Rooms House, Ordos, Office KGDVS, 2012; 2) Can Jaime i n' Isabelle, Palma de Majorca, TEd'A arquitectes, 2011 (Source: Authors' archive)

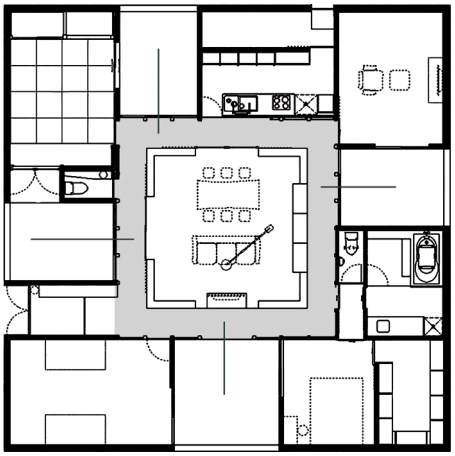
introduced by extending linear branches. A variation of this type is seen in the 25 Rooms House (Ordos, 2012) by Office KGDVS, where the circular connection's profile may vary, but the system remains closed as views from the movement direction do not extend to the exterior environment. In contrast, the Can Jaime i n' Isabelle House (Palma de Majorca, 2011) by TEd'A arquitectes features expansions where the movement flow changes direction, deviating from the strict square definition of the circular connection. (Figure 85)

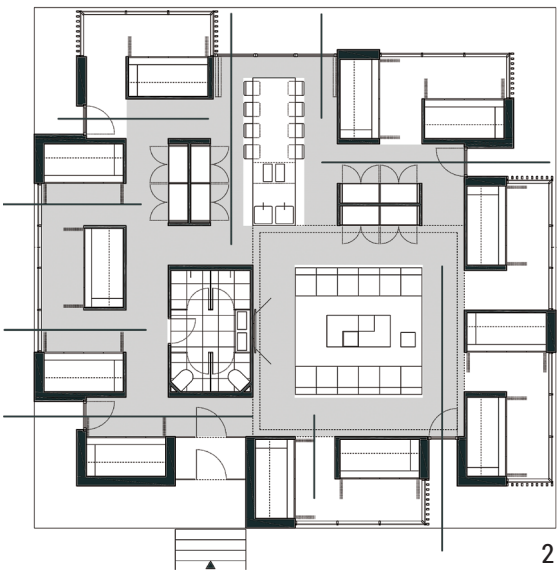
The determined open circular connection introduces communication openings in specific segments that extend towards the surroundings, often strategically placed where the movement direction changes. This design approach aims to enhance the sense of spaciousness compared to the closed circular connection type. The decision to open internal spaces towards the surroundings depends on both the architect's vision and the contextual considerations of the house's location. Lines of sight towards the environment can originate from static positions where occupants typically spend time, such as lounging in a living room, working at a desk, or cooking in the kitchen. These viewpoints can also result from active engagement within the living space, including movement and various daily activities. The value of opening the circular connection lies in its capacity to create an illusion of expansiveness or boundlessness within limited spatial confines. Generally, there are three main strategies for achieving horizontal openness in the circular connection: 1) Side openings concerning the direction of movement, 2) Axial openings along the direction of movement, and 3) Combined openings, providing the opportunity for a different view at any given moment. In the Black Pyramid House (Toyama, Yukihide Mizuno, 2007), deliberate side views were engineered to highlight directed observation of the surrounding space, although the central focus remains on connecting the core zone of the house with its environment. In situations where elongated plots or building structures dictate a predominant direction of movement within the circular connection, it is common to have axial openings aligned along the object's main axis. In more unique scenarios, such as with "cluster" structures[268] characterized by internal space layouts conducive to opening up in two or more directions, it becomes possible to establish not just a single circular connection but an entire network of circular connections with multiple openings towards

268 "Cluster buildings" refer to groupings of houses or spaces within a single structure arranged closely together, forming a dense cluster of individual spaces while also functioning as a unified whole. Their interconnected design allows for visual integration between interior and exterior spaces.

the surroundings. A notable example is the Co-living House project (competition solution by Studio Alfirevic in 2017), where a system of circular communications was developed to offer extended views in various directions, aiming to seamlessly integrate the natural environment into the house interior. (Figure 86)

The system of determined circular connections involves a sophisticated integration of multiple circular communications into a cohesive system, allowing for interconnection or intertwining. It is typical to distinguish between the circular connection linking daytime functions and one or more communications that unify nighttime spaces, as exemplified in the apartments within the Felix & Regula buildings (Zürich, designed by Loeliger Strub Architektur in 2012). Adhering to a similar design principle, Aires Mateus incorporated multiple circular communications in the House in Litoral Alentejo (Alentejo, designed by Aires Mateus in 2000), establishing a hierarchical structure with a primary connection framing the communal space and secondary connections linking individual rooms and utility spaces. The motivations behind forming circular connection systems can vary widely, ranging from enhancing spatial functionality, as





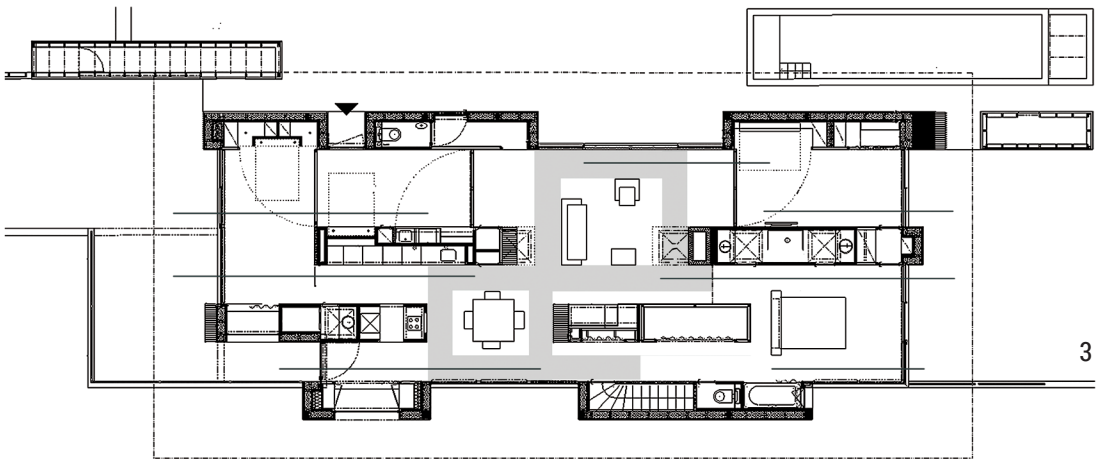


Figure 86 Determined open circular connection: 1) Black Pyramid House, Toyama, by Yukihide Mizuno, 2007; 2) Co-living House, competition solution, by Studio Alfirević, 2017; and 3) La Maison Etirée, Lyon, by Barres & Coquet, 2011 (Source: Authors' archive)

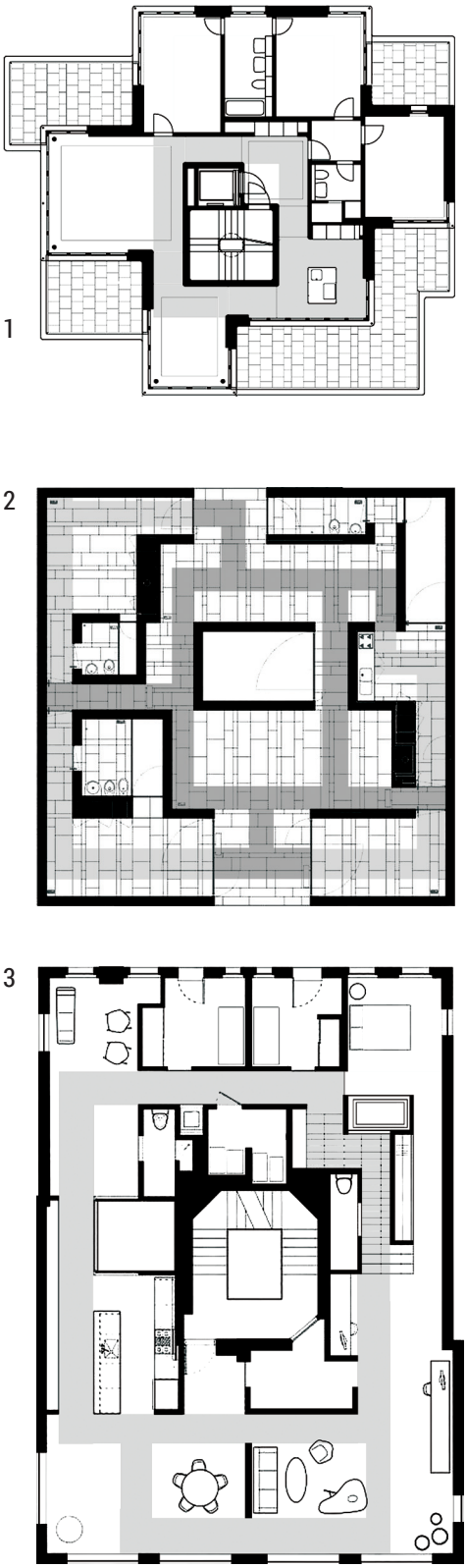


Figure 87 Systems of determined circular connections: 1) Felix & Regula, Zürich, Loeliger Strub Architektur, 2012; 2) House in Litoral Alentejo, Litoral Alentejano, Aires Mateus, 2000; and 3) Outside-In Loft, Boston, Howeller+Yoon, 2008 (Source: Authors' archive)

seen in the mentioned examples, to specific needs such as in the reconstruction of the Outside-In Loft apartments (Boston, designed by Howeller+Yoon in 2008). In this case, the merging of two units necessitated the creation of a primary circular connection along the apartment's perimeter, complemented by secondary connections branching off from the main one. (Figure 87)

A free circular connection allows for the creation of diverse trajectories within the same space, achieved through continuous circulation, a broader spatial profile, and loosely defined boundaries of the circular connection. In environments without barriers such as doors that delineate passages between spaces, the circular connection adopts a more open and unrestricted nature. Movement within the space becomes fluid and less constrained by a consistent width profile, offering opportunities for enhanced observation and interaction with elements within the interior. An excellent illustration of this concept is the Light Walls House by mA-style Architects in Toyokawa, completed in 2013. Here, the primary spatial organization revolves around a free circular connection, facilitating spontaneous arrangements of white volumes (auxiliary spaces). This layout encourages unrestricted movement and allows occupants to observe these volumes as if experiencing an abstract spatial composition. A similar approach to spatial organization can be observed in House 5 (Texas, designed by John Hejduk), where a free circular connection is formed around walls and freely positioned furniture elements, promoting a dynamic and interactive living environment. In instances where the circular connection takes on an entirely informal character, as demonstrated in the House of the Future for the Smithson couple in London by Alison

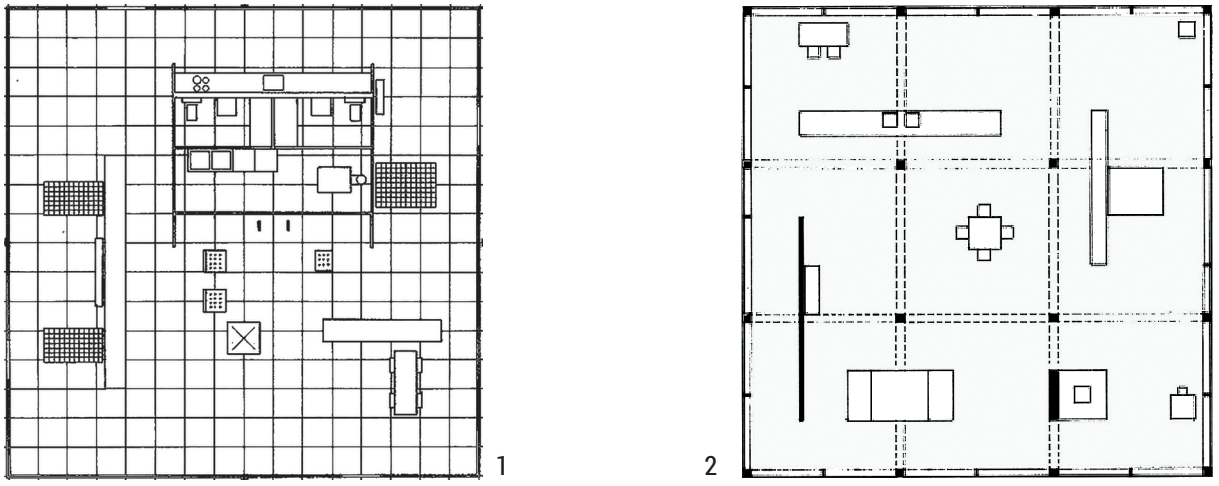


Figure 88 Free circular connections: 1) 50x50 House for Mass Production, Unbuilt, Ludvig Mies van der Rohe, 1951; 2) House 5, Texas, John Hejduk, 1980 (Source: Authors' archive)

& Peter Smithson in 1956, the focus may shift from experiencing individual elements within the space to appreciating the expressiveness and unique qualities of the interior space itself. (Figure 88)

When considering the durability or frequency of circular connections in residential spaces, three theoretical situations can arise: 1) constant circular connection, where it is consistently utilized; 2) intermittent circular connection, formed and used when doors and movable partitions are opened; 3) potential circular connection, emerging only in rare or exceptional situations when usually closed doors and movable partitions are opened. In the Ant-house (Shizuoka, designed by mA-style architects in 2012), a smaller perforated house forms the central core of the residential space. This core encompasses essential areas such as the toilet, bathroom, storage, staircase, and seating area. Surrounding this core, a continuous circular connection unfolds, allowing inhabitants to experience the core as a sculptural motif within the living space. An example of an intermittent circular connection is evident in the Chermayeff House (Garrison, designed by SO-IL in 2009). Here, the circular connection encircles the atrium and kitchen block, facilitating constant connectivity between the entrance, hallway, living room, and glazed terrace, especially when doors and movable partitions are opened. In the lateral segment of the house, there's an intermittent auxiliary circular connection formed among the bedroom, bathroom, and service area. Haus Steiger (located in Bergstrasse, Zürich, designed by R. Steiger and F. Steiger in 1963) features a blend of residential and workspace tailored to the architects' needs. The primary circular connection consistently links the office, living room, dining room, studio, staircase, and kitchen. However, the potential for a circular connection arises in very rare situations, such as connecting the bedroom, wardrobe, and bathroom with the studio, dining room, and living room. This type of connection is not developed as a constant feature due to potential functional conflicts, especially when directly linking an intimate space like the bathroom with the studio, which serves for work and client reception. Therefore, a controlled approach is preferable to avoid such conflicts. (Figure 89)

When examining the functional interplay between multiple circular connections within a residential space, their hierarchy or significance can classify them as primary or secondary, denoting independence or

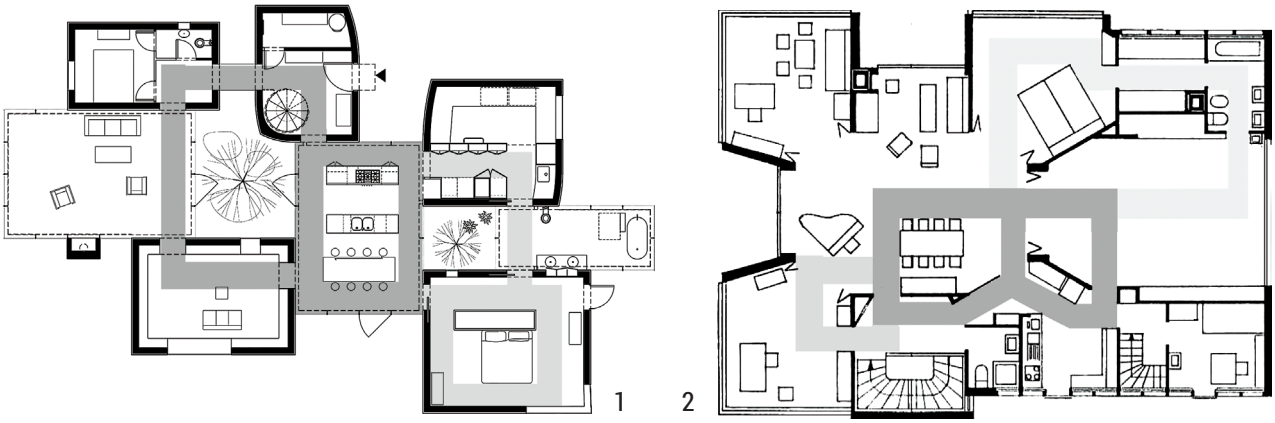


Figure 89 Characteristic examples of constant and intermittent circular connections: 1) Chermayeff House, Garrison, SO-IL, 2009 и 2) Haus Steiger, Bergstrasse, Zürich, R. Steiger, F. Steiger, 1963 (Source: Authors' archive)

dependence. A primary circular connection operates autonomously, possessing its own continuity and frequency. It's notably prevalent in residential layouts where frequent connections are crucial, such as between living rooms, dining areas, and kitchens; or between offices, lounges, living rooms, and dining rooms; as well as linking entrance areas with key living spaces like living rooms, dining areas, and kitchens, among others. On the other hand, a secondary circular connection relies on the existence of a primary connection to which it is subordinated. It serves to connect spaces where frequent connection is not as vital, often bridging residential areas with utility spaces or linking utility spaces internally. This secondary connection is essential for optimizing functionality within the home. While this study only touches on a few representative examples of circular connections, real-world applications often feature numerous variations and combined patterns. Consequently, this area remains rich for ongoing exploration and research, offering diverse possibilities in residential design.

Exploring various implementations of circular connections in residential spaces, a critical focus for further theoretical exploration and practical application involves understanding the role and purpose of circular connections in spatial-functional organization within homes. It is essential to highlight the primary reasons for utilizing circular connections in residential architecture:

- Functional:

a) Circular connections are often employed to achieve clear differentiation of functional zones within residences. This includes dividing spaces into day and night areas, residential and service units, or accommodating generational divisions. Circular connections typically isolate rooms such as bathrooms, staircases, storage areas, service zones, dens, kitchens, and bedrooms into distinct units or cores.

b) They facilitate better connectivity among functional units that might be too distant without such connections. Introducing auxiliary circular connections for individual spaces like bedrooms, kitchens, terraces, balconies, and even bathrooms and toilets enhances flow, albeit sometimes at the cost of reduced privacy levels and functional challenges.

c) Circular connections help in achieving greater safety during emergencies like attacks or fires by avoiding structures with dead ends, allowing smoother evacuation routes.

- Aesthetic:

a) Circular connections fulfill the desire for visual emphasis and contemplation of motifs within a space. These motifs can range from freestanding walls (as seen in Mies van der Rohe's projects) to furniture blocks and communication elements like closet rows, shelves, staircases, elevators, and even freestanding spaces or groups of spaces such as technical cores and utility areas.

b) They contribute to achieving greater spatiality and alleviating feelings of cramped space. Circular connections or systems of circular communications within an apartment create a sense of flowing space, enhancing comfort and reducing or preventing feelings of claustrophobia.

c) Circular connections are utilized to achieve representative visual effects, deepen perspectives within the apartment, and establish visual connections between the interior and exterior environments.

4.6. Emphasizing elements within the assembly

Accents in architecture encompass a wide range of natural and artificial elements that, within a specific context, capture attention with their unique attributes, playing pivotal roles in shaping intricate design concepts. The fireplace, as one of the oldest constitutive motifs, albeit in a modernized form, continues to find relevance in contemporary architecture in the guise of fireplaces or stoves. The fireplace has historically held significant importance as a constitutive motif, notably evident in the prairie houses designed by Frank Lloyd Wright. In these designs, the fireplace occupies a central or near-central position within the composition, accentuated by its size and prominence, serving as a focal point conducive to family gatherings and social interactions.[269] This approach is exemplified in notable works such as the Robie House (Chicago, Frank Lloyd Wright, 1909) and the Darwin-Martin House (Buffalo, Frank Lloyd Wright, 1905), where the fireplace's position and design contribute significantly to the spatial dynamics and aesthetic appeal of the interiors.

The incorporation of wood sourced from the site stands as another prevalent natural motif influencing the development of complex architectural designs. Renowned for its aesthetic appeal and unique properties, wood often assumes a central role as a focal point within architectural spaces, adding both visual interest and functional significance. This approach is exemplified in notable examples such as the Shell House (Kitasaku, ARTechnic Architects, 2008) and the Tree House (London, 6a Architects, 2013). In these projects, the intricate architectural organization stems from a deep respect for the inherent qualities of wood, which is carefully integrated into the structure. This not only enhances the building's facade but also strategically orients interior views towards these natural focal points, creating harmonious connections between the built environment and the surrounding landscape. (Figure 90)

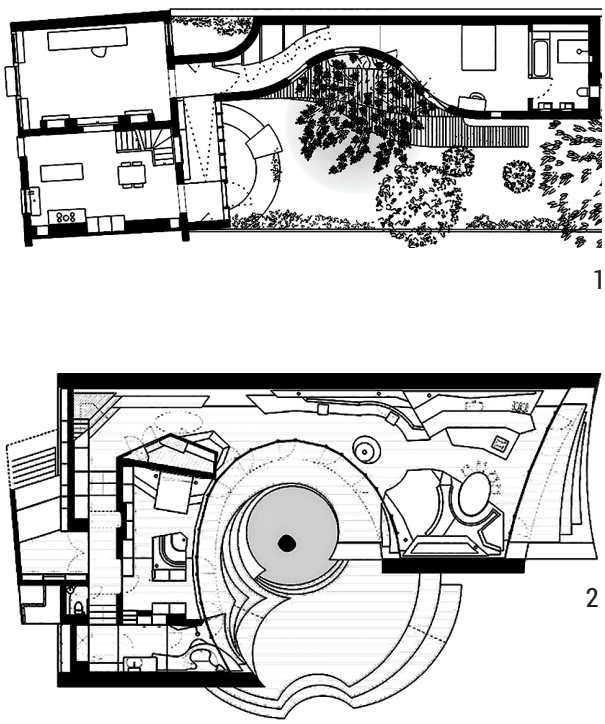
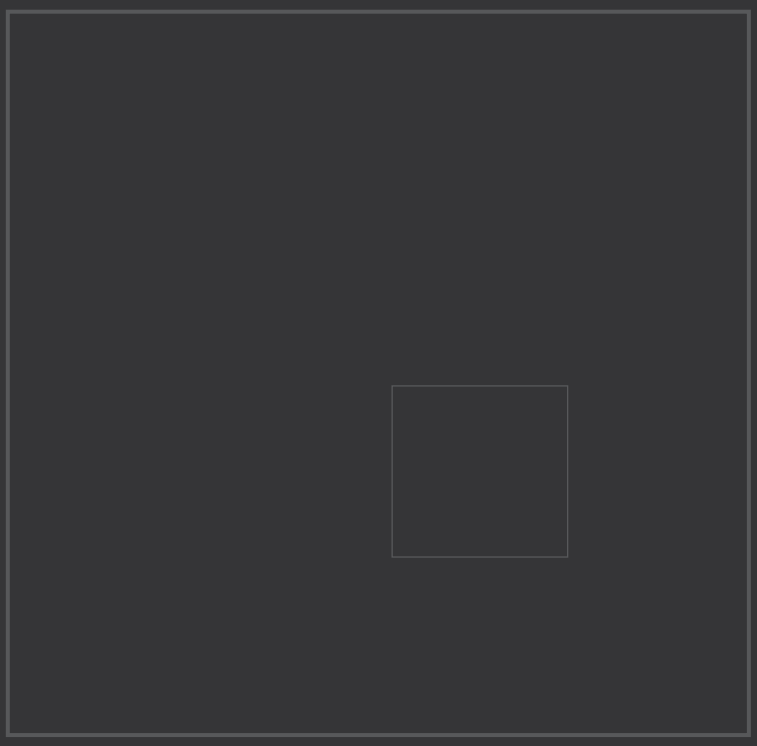
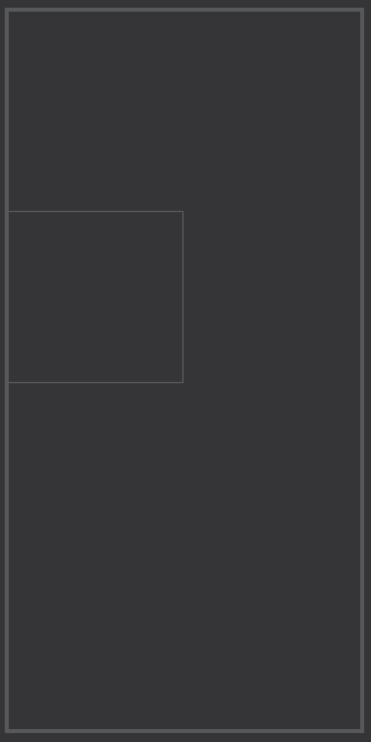
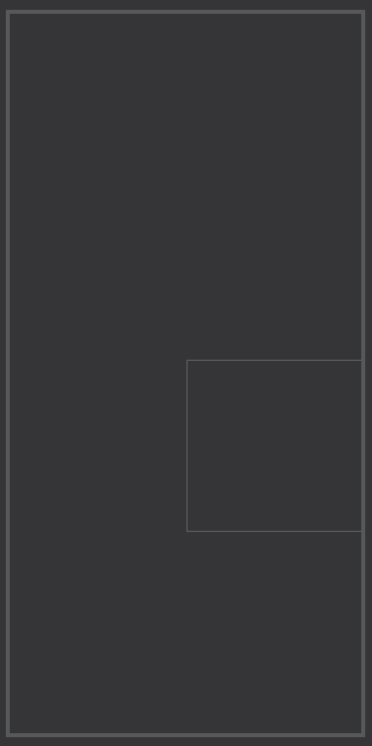
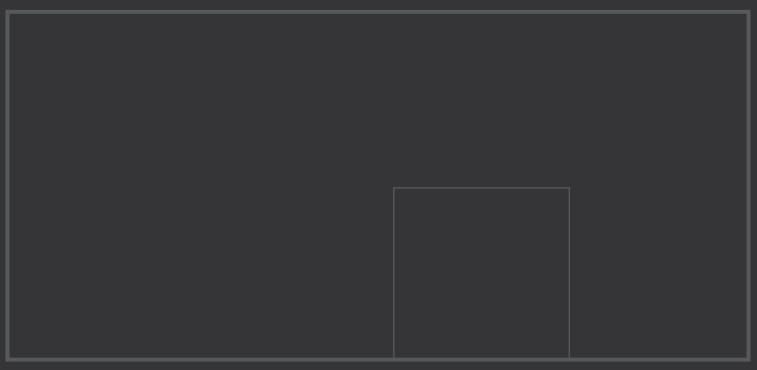


Figure 90 Natural or architectural accent motifs: 1) Tree House, London, 6a Architects, 2013; 2) Shell House, Kitasaku, ARTechnic Architects, 2008 (Source: Authors' archive)

269 Koile, "Formalizing abstract characteristics of style."



V PERCEPTUAL PRINCIPLES

5.1. Perception of spatiality

The concept of spatiality plays a crucial role in designing environments aimed at achieving specific visual effects or enhancing spatial comfort. Various methods are employed to achieve this goal, ranging from shaping physical space boundaries through open plans, flexibility, enfilades, or circular connections, to strategically opening spaces towards their surroundings either partially, directionally, or completely. Optical illusions are also utilized to redefine perceptions of space boundaries. Depending on the method employed, spatial contours can be clearly defined and readily apparent, or a space may conceal its full qualities until experienced dynamically, requiring movement through it to be fully understood. In instances where physical alterations are limited or as a complement to existing strategies, virtual augmentation through optical illusions can be utilized to alter the perceived spatial image. This multifaceted approach underscores the nuanced interplay between design elements and human perception in shaping spatial experiences.

Spatial perception is intricately influenced by various factors such as the inherent characteristics of the space, the observer's vantage point, the mode of observation (whether static or dynamic during movement), the observer's cognitive capacity to perceive, sense, and imagine, among other parameters. Numerous researchers across diverse fields such as philosophy, architecture, geography, sociology, and psychology have delved into these aspects of spatiality, exploring questions regarding its nature, achievement, and the perceptual effects it engenders.[270] A notable contribution to understanding spatiality within interiors can be found in Apollon Spiliotis's dissertation titled "Illusionism in Architecture: Anamorphosis, Trompe l'oeil, and other illusionistic techniques from the Italian Renaissance to the present." In this work, Spiliotis delves into early and contemporary instances of architectural illusionism, examining the techniques employed to manipulate the observer's perception and offering valuable insights into the nuanced realm of spatial perception and representation.[271]

Enhancing spatiality is a critical aspect of interior design. Its importance is evident across multiple dimensions of interior space perception. This includes visually expanding the interior boundaries and mitigating feelings of claustrophobia, especially vital in compact spaces. Furthermore, it plays a role in enhancing comfort and creating a distinctive visual impact, often seen in larger

270 Acre, *Spatial Quality Assessment for Energy-Efficiency Renovation of Dwellings*; Erkelens, "Perspective Space as a Model for Distance and Size Perception."; Farrell, *Historical and Philosophical Foundations of Psychology*; Čanak, „Otvoren ili zatvoren stan."; Merriman, et al., "Space and Spatiality in Theory."; Wang, "Formal Descriptions of Cognitive Processes of Perceptions on Spatiality, Time, and Motion."; Hertzberger, *Space and the Architect: Lessons in Architecture 2*; Van de Ven, *Space in Architecture: The Evolution of a New Idea in the Theory and History of the Modern Movements*; Ie Lie, *An Analysis of the Formal Qualities of Space in Architecture*; Rapoport, "The Study of Spatial Quality."; Laird, "Mental Spaciousness."

271 Spiliotis, *Illusionism in Architecture: Anamorphosis Trompe l'Oeil and Other Illusionary Techniques From the Italian Renaissance to Today*.

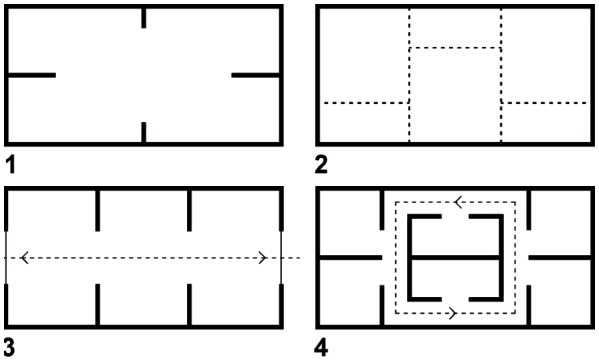


Figure 91 Achieving spatiality through space configuration: 1) open plan, 2) spatial flexibility, 3) enfilade, and 4) circular connection (Source: Authors' drawing)

interiors.[272] The perception of spatiality within an interior engages all senses, with visual perception typically being the most pronounced. However, auditory and olfactory elements are equally impactful in shaping the overall experience of a space.

The quest for enhancing spatiality can significantly influence the functional organization of elements within a space. For instance, furniture arrangements may prioritize optimal visibility during use, or the selection of furniture with specific dimensions may aim to establish proportional harmony within the space. These considerations contribute to a nuanced sense of spatiality, as the same space can be perceived differently from various viewpoints. This effect can also be achieved by incorporating smaller or larger furniture items into the space, where smaller pieces create an illusion of larger space, and larger ones contribute to a sense of coziness and intimacy. When physical means are limited, architectural design frequently incorporates illusions to manage proportions and alter the visual perception of elements.[273] These illusions can create effects such as weightlessness, dematerialization of surfaces, symmetry, smaller or larger sizes, and different spatial distances.[274] Apart from artistic techniques like *quadrature, anamorphosis, and trompe l'oeil,* which may not directly apply to this context, achieving spatiality in interiors typically involves employing various architectural principles, which can be categorized as follows:

272 Al-Zamil, "The Impact of Design Elements on the Perception of Spaciousness in Interior Design."

273 Throughout history, numerous interiors have been designed with a primary focus on achieving spatiality. Examples of such designs can be traced back to the Renaissance and Baroque periods. Noteworthy examples include the Church of Santa Maria at San Satiro (Milan, designed by Donato Bramante in 1482), Teatro Olimpico (Vicenza, designed by Andrea Palladio in 1585), Palazzo Spada (Rome, designed by Francesco Borromini in 1653), and the Scala Regia staircase (Vatican, designed by Gian Lorenzo Bernini in 1666). These interiors exemplify the application of spatial illusionism through techniques such as forced perspective (Spiliotis, *Illusionism in Architecture: Anamorphosis Trompe l'Oeil and Other Illusionary Techniques From the Italian Renaissance to Today.*). The achievement of spatial effects in Santa Maria at San Satiro, Teatro Olimpico, and the Scala Regia staircase relied on the convergence principle of basic planes or space segments. Conversely, at the courtyard of Palazzo Spada, the illusion of significant depth was crafted by skillfully reducing the dimensions of columns and the spans between them, aligning their directions to converge, and gradually lowering the ceiling height toward the depth of space. Numerous visual artists, including Andrea Mantegna, Pietro da Cortona, Giovanni Lanfranco, and Giovanni Battista Tiepolo, engaged in blending perceptual properties of illusionist painting with architectural interiors. Notable examples include Andrea Pozzo's ceiling painting at the Church of Sant'Ignazio in Rome (1685) and Baldassare Peruzzi's frescoes in the Hall of Perspectives at Villa Farnese (1510) in Rome. These artists adeptly manipulated the perceptual qualities of architectural spaces through illusionist fresco techniques.

274 Klesseck, *Architecture of Illusion: An Investigation Into Cinematic Deception in Camden Town, London*.

1) Principle of space configuration:
   - Space unification (use of open plan)
   - Space linkage (use of enfilade and circular connection)
   - Space variability (use of flexibility)
2) Principle of surface dematerialization:
   - Use of perforated surfaces
   - Use of transparent surfaces
3) Principle of illusionism:
   - Use of reflective surfaces
   - Use of forced perspective
   - Use of "light source"
   - Use of coloristic perspective
4) Principle of framing the vantage point

5.1.1. Space configuration principle

The fundamental principle for achieving spatiality in an interior is space configuration, which broadly refers to the relative arrangement of elements in three-dimensional space. In a narrower sense, it refers to the process of defining dimensions, structuring, and organizing spaces functionally.[275] A higher level of spatiality is often achieved by unifying spaces into a cohesive whole using the open plan approach. This allows for flexible connections as required, whether arranged in a linear sequence through the enfilade principle or in a circular arrangement via a circular connection. (Figure 91)

Open plan in architecture embodies the principle of integrating spaces into a larger whole, thereby minimizing the boundaries between distinct spatial-functional units to varying degrees.[276] There are generally two directions of openness in the plan: internal, which involves opening from within, and external, which involves opening towards the environment. An extreme example of internal openness is the concept of an all-in-one space, where fixed or movable barriers are omitted within the spatial framework, enabling the space to be perceived as a cohesive whole from any vantage point.

The concept of spatial flexibility in architecture usually denotes "the ability for occasional space alteration," known as the principle of function superimposition. This principle allows for situations where spaces can transform into an all-in-one space or flowing space when movable barriers are removed."[277] Unlike the concept of an open plan, where the sense of spatiality remains consistent, the principle of flexibility offers the potential for occasional expansion or increased depth (less frequently height) of space. This flexibility depends on factors such as the degree of openness, the position of movable barriers, and their number, introducing a certain level of indeterminacy to space because it cannot always be perceived in its entirety.

Enfilade encompasses the principle of linearly connecting spaces, where windows and doors are arranged in long axial sequences between spaces. This arrangement creates an impression of considerable depth, grandeur, and spatial hierarchy. The spaces linked in an enfilade are typically aligned along an axis, establishing communication through a central corridor. However, there are variations of enfilade where spaces are shifted but still maintain a connection to the central

275 Mihailo Čanak's study underscores the distinction between the structure and organization of space. Structure, as he defines it, pertains to the quantity and nature of spaces present, whereas organization delves into the network of relationships between these spaces and their positioning within the overall complex. (Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*.).

276 Alfirević i Simonović Alfirević, "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."

277 Alfirević i Simonović Alfirević, "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."

1

Figure 92 Application of perforated surfaces in achieving spatiality: 1) Spiral House Project, Sou Fujimoto, 2007; 2) House N, Oita, Sou Fujimoto, 2008) (below) (Source: www.archdaily.com).

2

axis of movement. While enfilade shares similarities with an open plan in visually unifying smaller spaces, it differs in that the space cannot be fully perceived at once; one needs to move through it to grasp its entirety.[278]

Circular connection entails creating uninterrupted internal communication within a system of sequentially connected spaces. Its purpose is to establish continuity in linking spaces and reduce or eliminate the sensation of confined space. Unlike the concept of an open plan, where spaces are integrated into all-in-one space to achieve physical expansion and greater spatial comfort, a circular connection focuses on functional linking and creating a sense of enhanced spatiality.[279]

5.1.2. Surface dematerialization principle

The term "dematerialization" in this context refers to the extent of physical and visual reduction of elements in the interior (such as partitions, floors, or ceilings), thus creating a "porous" quality that allows for transparency. In a broader context, dematerialization involves freeing architecture from traditional constraints of solidity, stability, and durability in physical, social, and psychological aspects.[280] The use of partitions in interior design is often linked to space segregation in some form. Depending on the functions being separated,[281] whether

278 Alfirević i Simonović Alfirević, "Design Principles for Achieving Spatiality in Living Space."

279 Alfirević i Simonović Alfirević, "'Circular Connection' Concept in Housing Architecture".

280 Čarapić, „Da li je materijalizacija arhitekture neophodno materijalna?"

281 Mihailo Čanak analyzed an instance of spatial relationships and the potential for integrating functions within residential settings. A similar principle can be applied to examining additional functions within public interior spaces (Čanak, *Funkcionalna koncepcija i upotrebna vrednost stana*; Čanak, „Otvoren ili zatvoren stan.").

1

2

Figure 93 Application of transparent surfaces in achieving spatiality: 1) Glass House, New Canaan, Philip Johnson, 1949 (Source: www.archdaily.com); 2) Glass House, Carlo Santambrogio, Ennio Arosio (Source: www.santambrogiomilano.com); 3) Layered House, Hokkaido (Jun Igarashi Architects, 2008) (Source: www.archdaily.com).

due to olfactory, auditory, or visual concerns, partitions can vary from solid to partially or fully transparent, movable, or fixed. Integrating compatible functions can lead to the creation of versatile spaces, where the introduction of perforated or transparent partitions can add spatial depth and enhance overall spatial quality.

The implementation of perforated partitions proves exceptionally beneficial when there is a need to separate spaces for aesthetic or psychological reasons, such as achieving a specific level of intimacy. This type of barrier possesses a dual nature akin to a filter: it facilitates visual connection and spatial continuity while simultaneously providing visual separation. (Figure 92) Transparent partitions are particularly intricate in scenarios requiring

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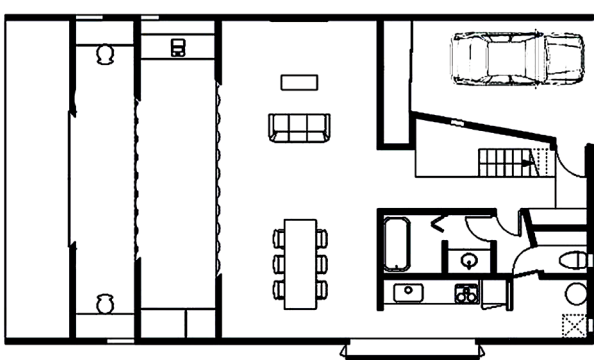
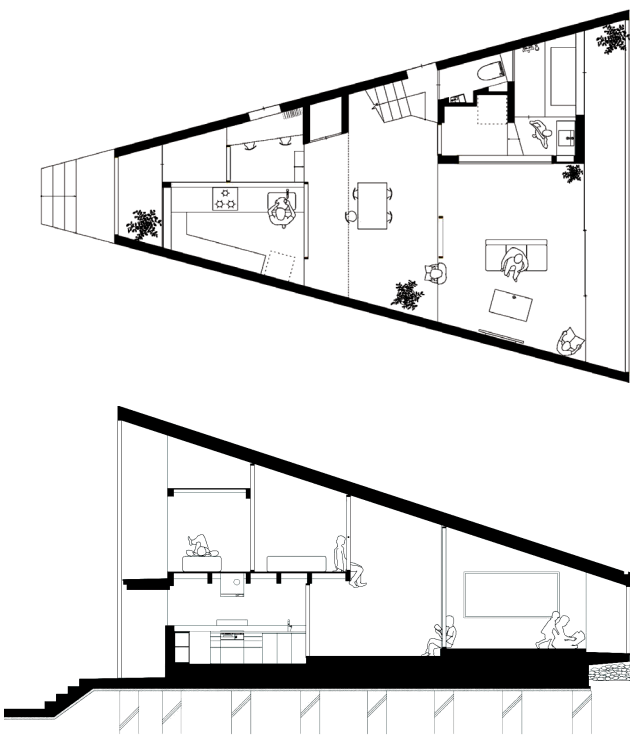


Figure 94 Application of reflective surfaces in achieving spatiality: Penthouse, Berlin, Lecarolimited, 2010 (Source: www.lecarolimited.de, photo Gerrit Engel)

Figure 95 The use of forced perspective in achieving spatiality: Unou House, Toyota Aichi (Katsutoshi Sasaki & Associates, 2012) (Source: www.archdaily.com)



separation due to unwanted sounds and odors, while maintaining visual unity, especially when aiming to extend the space into its surroundings (as in external openness of the plan). (Figure 93) In both instances, the physical boundaries of space undergo dematerialization, and the visual perception of spatiality is influenced by subsequent spatial planes.

5.1.3. Illusionism principle

Illusionism in art involves employing diverse techniques to craft an illusion of reality and influence the viewer's perception.[282] In architecture, this principle is predominantly utilized to alter experiences by manipulating perception and achieving spatiality. Techniques employed to create illusions of spatiality in interiors are primarily grounded in deliberate materialization and the use of various perspective effects.

The use of reflective surfaces stands out as a potent method to create a 'virtual' sense of spatiality. These surfaces do not alter the physical attributes of a space but rather generate an illusion of visual expansion or multiplication, depending on their arrangement and quantity. Mirrors, in particular, are highly effective in this regard, especially when placed opposite each other or in a cross configuration, effectively blurring the boundaries of the actual space. (Figure 94) Placing mirrors opposite the natural light source enhances the overall illumination within the room, contributing to the perception of larger dimensions.

Forced perspective is an optical illusion employed to simulate depth, height, or spatial relationships between

282 Spiliotis, *Illusionism in Architecture: Anamorphosis Trompe l'Oeil and Other Illusionary Techniques From the Italian Renaissance to Today.*

elements that diverge from reality. In architecture, this illusion of spatiality is typically achieved by creating converging lines or planes in space, or by proportionately diminishing elements and their perceived distances. (Figure 95)

The principle of the "light source," akin to aerial perspective in visual arts,[283] involves illuminating space so that surfaces and objects closer to the observer appear darker, gradually becoming lighter as they recede. Spatiality is achieved through the light source principle primarily in two ways: by situating the natural light source opposite the observation point or by adjusting the intensity of artificial lighting in a similar direction. Placing doors or windows strategically to capture characteristic views enhances the impression of opening the interior space outward, creating a visual expansion of the space. (Figure 96)

Coloristic perspective is a technique that visually conveys spatiality through the optical effects of warm and cool colors. Warm colors create an expansive effect, making elements appear closer, while cool colors create a receding effect, making them appear farther away. In this technique, foreground elements are accentuated using warm colors like red, yellow, and orange, whereas distant areas are subdued using cool colors such as blue, green, and purple. While this principle is commonly used in visual arts, its application in architecture is limited because coloristic solutions are often seen as a secondary method for visual expression.

283 Aerial perspective refers to the technique of generating an illusion of depth in drawings and paintings. This is achieved by adjusting tonal values or colors to mimic the atmospheric effects that affect objects at varying distances. (Da Vinci, *Treatise on Painting*.).

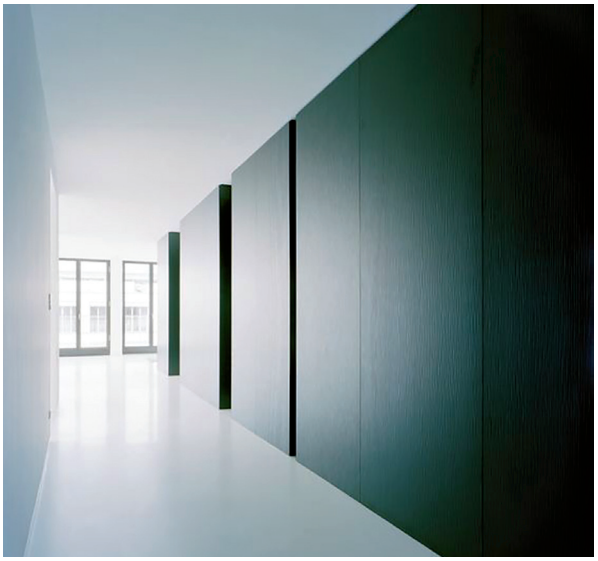


Figure 96 Application of aerial perspective and the 'light source' principle in achieving spatiality: Upper Eastside, Berlin, Axthelm & Rolvien, 2010 (Source: Authors' archive)

5.1.4. Principle of framing the vantage point

The concept of the vantage point involves framing the position or orchestrating the viewpoint from which spatiality is experienced. Depending on the perspective and the way space is perceived, the sense of spatiality can vary significantly. The same space can seem smaller from one viewpoint and considerably larger from another, highlighting the importance of considering different perspectives in functional space organization, particularly when observing space during its use in the design process. (Figure 97)

Anamorphosis is a variant form of this principle, involving the perception of a distorted representation of space that reveals its true appearance when observed from a specific position and in a specific manner. The application of anamorphosis is highly uncommon in architecture due to its requirement for a formalistic design approach, which may conflict with the functional needs of users on a larger scale.

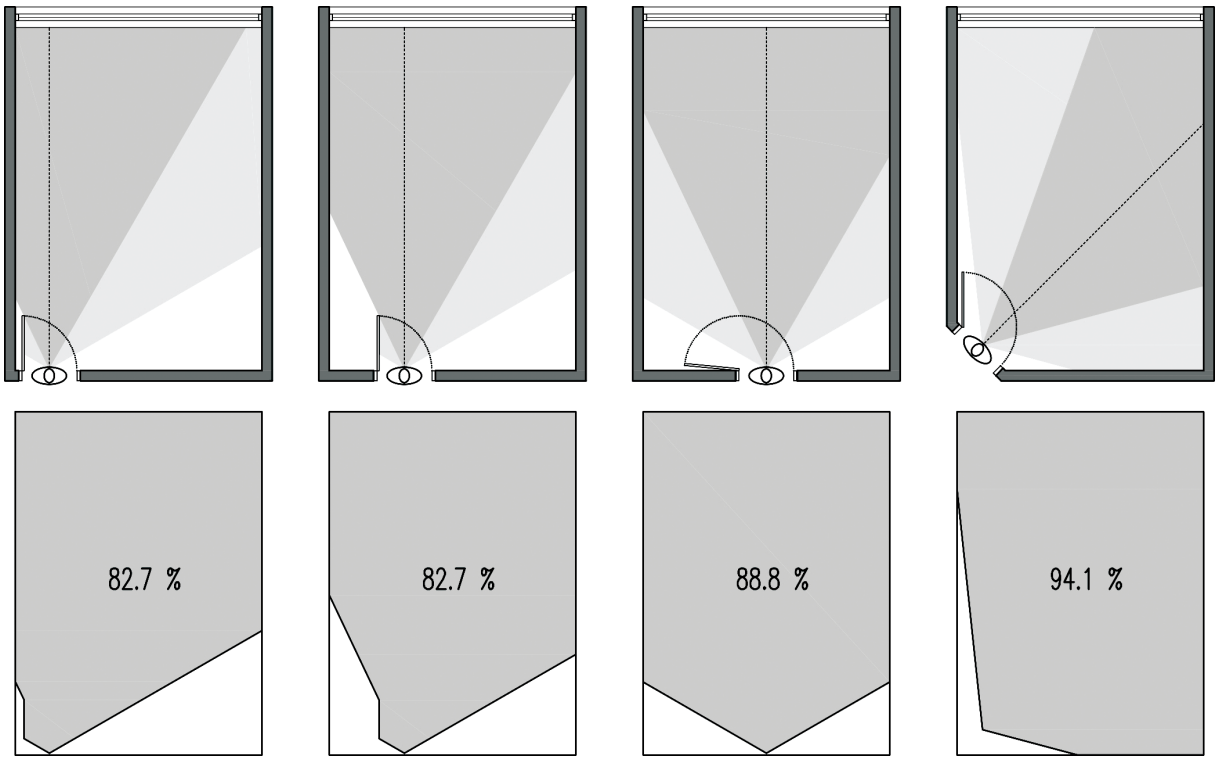


Figure 97 Achieving spatiality by framing the vantage point (Source: Author's archive)

Each of the mentioned principles can contribute to varying degrees to achieving the perception of spatiality, primarily depending on how and to what extent they are applied. It is important to note that these principles can often be combined, facilitating the attainment of higher levels of spatiality as their optical effects complement each other. These combinations are typically applied within similar categories. For instance, in spatial configuration, principles like enfilade and circular connections are often complemented by an open plan and flexibility, although other combinations are feasible. Similarly, in surface dematerialization and the illusion of spatiality, common combinations include incorporating perforated and transparent surfaces along with the "light source" principle, enabling internal and external space openness.

It is important to emphasize that individual principles have varying spatial effects, which can be experienced in different ways: 1) from any segment of space (open plan, circular connection, perforated and transparent surfaces), 2) by passing along a certain trajectory (coloristic perspective and the principle of the light source), or 3) from a specific vantage position (anamorphosis).

From the preceding analysis, it is evident that spatiality in interior design is shaped by both functional and perceptual considerations (motives). The functional aspect encompasses principles of spatial configuration derived from the practical organization of space. On the other hand, the perceptual aspect is closely associated with principles such as dematerialization, illusionism, and vantage point framing, which directly engage the aesthetic vision of the architect.

5.2. Experience of spatial comfort

The perception of reality is a multisensory experience, with each sense contributing to a certain degree of comfort. When it comes to perceiving space and spatial characteristics, the most significant influences come from visual and tactile sensations, which often take precedence over other sensory inputs. In scientific discourse, comfort is generally categorized into several fundamental aspects such as visual, thermal, auditory (sound), olfactory (smell), and hygiene comfort. However, spatial comfort, while widely discussed in architecture, lacks a precise definition within scientific contexts. Despite its frequent use in practical contexts, the term remains somewhat nebulous, yet it is commonly understood to refer to the overall pleasantness of a space in terms of its spatial qualities.

The term "comfort" typically refers to a sense of pleasantness or a state of both physical and mental well-being.[284] Over time, the concept of comfort has evolved, leading to diverse interpretations across various fields including anthropology, sociology, biology, physiology, geography, history, and others. Numerous studies have been undertaken to define comfort more precisely and to thoroughly investigate the conditions and criteria necessary for attaining it.[285]

The concept of comfort is primarily associated with a specific feeling of coziness and well-being, influenced by various parameters depending on the type of comfort being considered. In addition to the conventional uses of the term such as thermal, auditory, and olfactory comfort, architecture also introduces the notion of "spatial comfort," recognized as a fundamental human need. Many experts argue that spatial comfort arises from well-designed functional spaces and the ergonomic

284 Chappells and Shove, "Comfort: A Review of Philosophies and Paradigms".

285 Boduch and Fincher, *Standards of Human Comfort: Relative and Absolute*; Crowley, *The Invention of Comfort: Sensibilities and Design in Early Modern Britain and Early America*; Shove, *Comfort, Cleanliness and Convenience – The Social Organization of Normality*; Shove, "Converging Conventions of Comfort, Cleanliness and Convenience."; Kolcaba, "A Taxonomic Structure for the Concept Comfort."; Kolcaba and Kolcaba, "An Analysis of the Concept of Comfort."; Siefert, "Concept Analysis of Comfort."; Passe, "Designing Sensual Spaces: Integration of Spatial Flows Beyond the Visual, Design Principles and Practices."; Jolović, *Mikro i makro prostorno vremenski obrasci za provođenje slobodnog vremena i uživanje u dokolici*; Stupar, *Arhitektonički komfor u predškolskim ustanovama* etc.

Table 8 The most significant interpretations of the term comfort

Comfort is ...	Authors
... a feeling of contentment, a sense of cosiness, or a state of physical and mental well-being.	H. Chappels, E. Shove
... the state of having met basic human needs for ease relief, and transcendence.	K. Kolcaba
... relief from discomfort.	K. Kolcaba, R. Kolcaba
... an optimal state of the relationship between the body and the space, which is pleasing to the user, situated between the user's needs and desires.	D. Stupar

layout of the physical environment.[286] However, despite its extensive practical application and the lack of a precise scientific definition, spatial comfort is generally understood as the overall comfort experienced within a space. The complexity of achieving spatial comfort lies in the relative nature of its parameters, which are more intricate to analyze compared to parameters for thermal or auditory comfort. Moreover, there is a limited number of scientific studies dedicated to spatial comfort, indicating that this area of research is still developing and lacks comprehensive understanding.

When discussing spatial comfort, it is important to highlight the phenomenological aspect of observation, which underscores human experience and the individual perception of space. In this regard, the insights of theorists such as Christian Norberg-Schulz, Edward Hall, Witold Rybczyntski, Juhani Pallasmaa, and Peter Zumthor hold particular significance. These theorists have shed light on specific aspects that indirectly contribute to determining spatial comfort.

Witold Rybczyński explores comfort as a fusion of sensations, many of which reside in the subconscious and extend beyond mere physical aspects to encompass emotional and intellectual dimensions. This complexity renders comfort challenging to articulate and quantify.[287] His examination traces comfort's evolution over time, linking it to concepts like intimacy, privacy, the importance of illumination, fresh air, and other factors. Juhani Pallasmaa emphasizes the multisensory nature of architectural experiences, asserting that the quality of space, and thus comfort, is evaluated through all senses. He underscores that the essence of home and comfort lies in experiencing a sense of intimate warmth.[288] Edward Hall's perspective on comfort centers on the presence of others in a space and the proxemic distances that influence how individuals use and perceive that space. He identifies four distance zones—intimate, personal, social, and public—that significantly impact comfort, especially in shared spaces.[289] Christian Norberg-Schulz highlights two pivotal criteria, space, and character, in shaping the "spirit of place." Space, in his view, pertains to the three-dimensional arrangement of elements constituting a place, while character encapsulates the ambiance of a place, which can relate to perceptions of comfort in various aspects.[290] Peter Zumthor delves into the notion of atmosphere, which he believes arises from the sensory qualities emitted by a space, resulting in experiences such as mood, well-being, harmony, and beauty. He particularly notes the crucial role of light in enhancing a space's pleasantness, comfort, livability, and visibility.[291]

Upon the literature analysis, it becomes clear that some authors equate spatial comfort with both visual and physical comfort, whereas others distinguish between them, leading to potential ambiguities in interpretation.[292]

According to the European standard, visual comfort is defined as "a subjective condition of visual well-being

286 Ikonne and Haliso, "Influence of Spatial Comfort and Environmental Workplace Ergonomics on Job Satisfaction of Librarians in the Federal and State University Libraries in Southern Nigeria."; Ural and Ural, "Colour and Spatial Comfort in Architectural Context."; Petković Grozdanović, et al., "The Spatial Comfort of Social Housing Units in the Post-Socialist Period in Serbia in Relation to the Applicable Architectural Norms."

287 Rybczynski, *Home: A Short History of an Idea*.

288 Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*.

289 Hall, *The Hidden Dimension*.

290 Norberg Schultz, *Genius Loci – Towards a Phenomenology of Architecture*.

291 Zumthor, *Atmospheres: Architectural Environments, Surrounding Objects*.

292 Elzeyadi, "Designing for Indoor Comfort – A Systemic Model for Assessing Occupant Comfort in Sustainable Office Buildings."

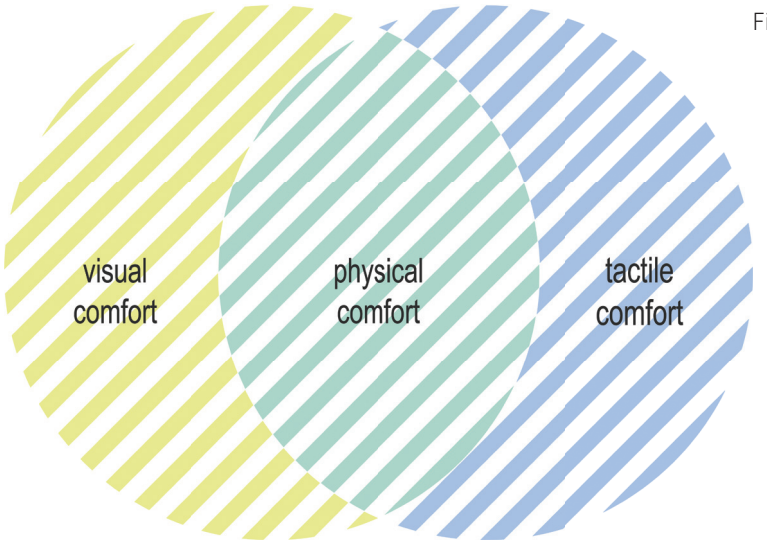


Figure 98 Domains of visual, physical, and tactile comfort (Source: Authors' drawing)

induced by the visual environment."[293] Most studies focusing on visual comfort prioritize domains such as light intensity, contrast level, and glare within a space. The influence of color, however, is less explored due to its relative nature compared to other visual aspects. Color perception often depends on personal associations and cultural characteristics, adding complexity to its study.[294] Consequently, studies like "Color and spatial comfort in an architectural context," which emphasize the role of color in creating a sense of spatiality and thereby enhancing spatial comfort, are relatively uncommon.[295]

Physical comfort, as defined by John Crowley, involves "self-conscious satisfaction with the relationship between one's body and its immediate physical environment".[296] This definition ambiguously intertwines the body's interaction with its immediate physical surroundings. Crowley's concept of physical comfort not only includes the tactile experience of one's body with the environment (which falls under ergonomics) but also considers the relationship between the body, space dimensions, and shape. This nuanced approach combines elements of both visual and haptic perceptions within the realm of physical comfort, incorporating aspects of visual and tactile comfort. (Figure 98) From this perspective, it becomes evident that spatial experience is influenced by both visual and haptic (tactile) perceptions, although they are not the sole determinants of spatial comfort. While visual and tactile aspects play crucial roles, achieving spatial comfort involves a broader consideration of physical parameters.

Based on the analysis of characteristic interpretations of the term spatial comfort present in the literature (Table 9), it becomes apparent that this term is frequently linked with concepts such as 'space function,' 'human activities,' 'engagements,' or 'use.' However, these associations do not entirely elucidate the concept since the sense of spatial comfort can manifest even in spaces lacking a specific purpose. Thus, it is crucial to emphasize that spatial comfort is not solely determined

293 ***. *"Light and Lighting – Basic Terms and Criteria for Specifying Lighting Requirements."*

294 Boduch and Fincher, *Standards of Human Comfort: Relative and Absolute*.

295 Ural and Ural, "Colour and Spatial Comfort in Architectural Context."

296 Crowley, *The Invention of Comfort: Sensibilities and Design in Early Modern Britain and Early America*, 750.

Table 9 Characteristic interpretations of the term spatial comfort

Spatial comfort ...	Authors
... is an ideal condition between the anthropometry of the human body and the activity adapted to the function of space.	Y. U. U. Ginting, N. Ginting, W. Zahrah
... is degree to which an environment is suitable for "human occupation and use."	I. Elzeyadi
... is an indicator of space quality	J. Jolović

by how a space is used, as this falls within the domain of spatial functionality. Instead, spatial comfort is better understood as the experience of pleasantness derived from its inherent qualities.

When considering a comprehensive definition of spatial comfort, it is essential to start from the premise that the pleasantness of a space essentially comprises a set of characteristics or qualities that users can perceive, touch, or imagine. In this regard, the following can be emphasized:

Spatial comfort is the feeling of pleasantness and satisfaction that an individual experiences while inhabiting a space characterized by specific physical, visual, and tactile qualities.

When discussing spatial comfort, it is necessary to distinguish between relative and absolute comfort. Relative spatial comfort refers to the subjective feeling of satisfaction stemming from diverse space qualities, personal preferences, and user characteristics. In contrast, absolute spatial comfort is defined as the cumulative satisfaction derived from the majority of space users' relative comforts.[297] Parameters for achieving absolute spatial comfort in specific elements can be defined by regulations or standards and used in design as guidelines for attaining the expected level of comfort. On the other hand, parameters for achieving relative spatial comfort can be applied when considering the preferences and characteristics of individual users. To establish and standardize parameters for achieving absolute comfort, empirical research is necessary to validate their impact on a broader user base.

Spatial comfort differs from other types of comfort in that it encompasses a wide spectrum, often defying precise quantification of the moment when an individual feels comfortable. This is unlike thermal comfort, which typically centers around a specific temperature like +22°C.[298] The range of values within which a person perceives spatial comfort in a given space is commonly referred to as the "comfort zone." In contrast to other comfort types, spatial comfort can be understood as a continuum of pleasantness extending between the extremes of claustrophobia and agoraphobia (or

297 Jolović, *Mikro i makro prostorno vremenski obrasci za provođenje slobodnog vremena i uživanje u dokolici*, 60.

298 Shove, "Converging Conventions of Comfort, Cleanliness and Convenience."

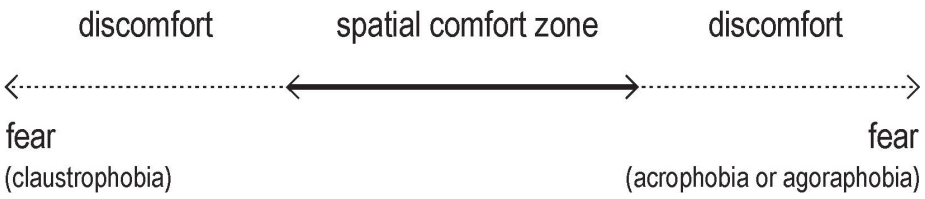


Figure 99 The range of spatial comfort zone and its relation to boundary states (Source: Authors' drawing)

acrophobia),[299] which does not exclude the occurrence of anxiety within the comfort zone; however, its presence is minimized. (Figure 99)

The established definition of spatial comfort suggests that three primary groups of parameters influence its attainment: 1) physical, 2) visual, and 3) haptic parameters. *Physical* parameters encompass space qualities experienced through visual or tactile perception, such as space boundary distances, configuration, openness to the environment, and shape. *Visual* parameters involve qualities experienced through visual perception, including the role of color and brightness in creating spatiality. *Haptic* parameters encompass qualities experienced through tactile perception, such as feelings of security, confinement, and memorability within the space.

5.2.1. Physical parameters

The distance of space boundaries (depth, width, and/or height) from the viewer's position is a crucial parameter influencing the perception of spatiality and, consequently, spatial comfort.[300] Achieving a sense of spatiality does not automatically guarantee spatial comfort, as their relationship hinges on individual perceptual abilities. Nonetheless, there exists a higher potential for attaining spatial comfort. Space boundaries are observable when they delineate the extent of vision or anticipated when their position cannot be directly seen but is inferred. If a boundary disrupts the visual field by being too close to the observer, it creates an impression of enclosing space and constraining the individual within it. Even if one is aware of the space's size from prior observation, extended exposure in such a position can lead to discomfort due to impaired visibility. Following this rationale, perceiving the depth, width, and height of a space can evoke different comfort impressions. Depth and width are typically observed frontally, with the line of sight nearly perpendicular to the boundary surface, while height is gauged as the gaze "glides" along its surface. (Figure 100) Moreover, it is noteworthy that the perception of spatiality and spatial comfort intensifies when the vista extends

299 Claustrophobia refers to a state of intense discomfort and fear experienced in enclosed or confined spaces. Acrophobia, on the other hand, is characterized by a fear of great distances from objects (commonly known as a fear of heights), while agoraphobia is associated with a fear of open spaces (Lourenco, Longo and Pathman, "Near Space and its Relation to Claustrophobic Fear."; Ukabi, "The Scale of Individual Space in Restructuring Perception of Phobia.")

300 The term "spatiality" encompasses a set of characteristics that define the quality of a space when viewed from a specific perspective. It is a crucial criterion for achieving spatial comfort and includes various parameters that have been examined in this study (Alfirević i Simonović Alfirević, "Design Principles for Achieving Spatiality in Living Space.").

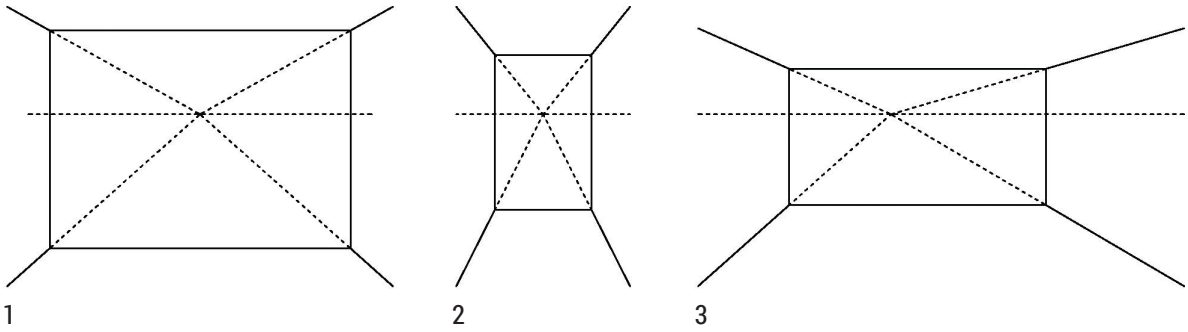


Figure 100 The impact of the distance of space boundaries on the experience of spatiality and spatial comfort: 1) shortening of space depth, 2) narrowing of space width, 3) reducing space height (Source: Authors' drawing)

unobstructed into the distance, as seen with reduced height or width of the space. This observation carries significance when arranging space and considering from which viewpoints space boundaries will be observed during regular use.

It is important to emphasize that spatial comfort is not solely determined by the usable floor area of a room, as often mentioned in literature as a parameter.[301] Instead, it is influenced by the fundamental dimensions of the space and how these dimensions are perceived. The dimensions and surfaces outlined in regulations and standards typically stem from an analysis of minimum and optimal dimensions for characteristic functional space setups, rather than from research aimed at establishing dimensional parameters for spatial comfort. While the distance of space boundaries falls under measurable parameters, the individual variability in experiences prevents the discussion of specific dimensions. Instead, it's more appropriate to consider ranges that may apply to a broader population. The minimum dimension that triggers discomfort, and in severe cases, claustrophobia, has not been empirically confirmed. However, it's generally understood that individuals may experience discomfort in spaces where the distance between walls is less than the width of outstretched arms (approximately 180cm), or when the height of the space is such that one can touch the ceiling with their hand (approximately 226cm).[302]

Spatial comfort is attainable through effective space configuration, such as integrating spaces into a larger whole following principles like an open plan, flexible connections as required, linear arrangement akin to an enfilade, or cyclic order facilitated by a circular connection.[303] While these parameters are not quantifiable

301 Ertürk, "A Method for Determining Spatial Requirements With Special Emphasis on User Comfort."; Elzeyadi, "Designing for Indoor Comfort – A Systemic Model for Assessing Occupant Comfort in Sustainable Office Buildings."; Petković Grozdanović, et al., "The Spatial Comfort of Social Housing Units in the Post-Socialist Period in Serbia in Relation to the Applicable Architectural Norms."

302 Lourenco, Longo and Pathman, "Near Space and its Relation to Claustrophobic Fear."

303 Alfirević and Simonović Alfirević, "Design Principles for Achieving Interior Spatiality."; Alfirević i Simonović Alfirević, "'Circular Connection' Concept in Housing Architecture"; Alfirević i Simonović Alfirević, "Open-Plan in Housing Architecture: Origin, Development and Design Approaches for Spatial Integration."

as they represent principles of space organization, their impact can be observed and acknowledged in practice.

An open plan in architecture integrates spaces into a larger unified whole, thus blurring the boundaries between distinct spatial-functional units to varying degrees. This integration can occur in two directions: internally, where the space "opens inwardly", and externally, where it "opens outwardly" to the environment. In either case, the space expands visually and/or physically, resulting in enhanced spatiality and increased spatial comfort.

The principle of spatial flexibility in architecture involves the potential for occasional alterations in space and the layering of functions, facilitating the creation of unified or flowing spaces when movable partitions are repositioned or removed. This principle holds significance as it allows for the periodic establishment of spatial comfort under basic standard conditions.

Enfilade embodies a linear spatial linkage principle where passages, doors, and windows are arranged in an axial sequence, producing an illusion of substantial spatial depth. This concept shares certain resemblances with the open plan approach since it seeks to visually enlarge interconnected smaller spaces. Unlike the open plan, however, enfilade does not afford a comprehensive view of space; one must traverse it to grasp its entirety. The sensation of spatial comfort within an enfilade configuration is particularly accentuated when observed along its axial linkage.

Circular connection is a principle that involves creating a continuous circular linkage between spaces, forming uninterrupted internal communication within a system of interconnected spaces. Its purpose is to establish a seamless flow of space and reduce the sense of confinement within the environment. The sensation of spatial comfort in spaces with circular connections is heightened when the entire path of movement is considered, emphasizing the dynamic experience of space rather than a static viewpoint.

The principle of space openness towards the environment involves arranging and aligning spaces to engage with the surrounding context. This concept originates from the desire of designers to capitalize on scenic views from within the structure, in one or more directions, while also enhancing the sense of spaciousness and comfort through visual connections between indoor and outdoor areas. External openness of space can manifest in several ways: 1) total openness – occurs when the entire space is integrated with the external environment, excluding auxiliary areas; 2) sectoral openness - involves incorporating external elements only into specific gathering or daily activity zones; 3) partial openness - includes individual spaces but not entire functional units; and 4) controlled openness - allows flexible barriers to be used, enabling selective opening or closure of connections as needed.[304] While complete openness to the environment sets the stage for spatial comfort, its actual realization depends heavily on the user's inclination toward introversion or extroversion. Achieving spatial comfort is not automatic with external openness; rather, it provides the potential for such comfort to be realized based on user preferences and interaction with the environment.

The shape of a space plays a crucial role in achieving spatial comfort, especially concerning its regularity and internal arrangement. Regarding the influence of regularity, arrangement, and density of elements determining the shape of the interior space, research by Vacit İmamoğlu indicates a relationship between

304 Čanak, „Otvoren ili zatvoren stan."

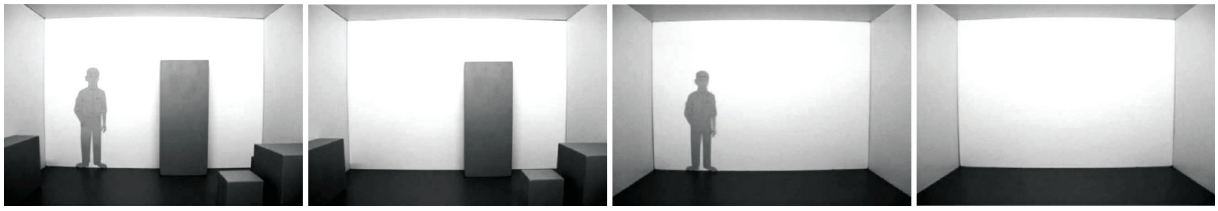


Figure 101 Impact of space fullness on the experience of spatial comfort (Source: von Castell, Oberfeld and Hecht, "The Effect of Furnishing on Perceived Spatial Dimensions and Spaciousness of Interior Space.")

space organization and the experience of spatiality and comfort.[305] İmamoğlu's research delves into the spatial fulfillment aspect rather than functional organization, emphasizing that well-organized and properly arranged spaces are perceived as more aesthetically pleasing and comfortable, whereas disorganized spaces are seen as cramped and less inviting.[306] In Dana Pop's book "Architecture, Perception, and Fear," six factors contributing to discomfort in a space are mentioned, including overcrowding, which can lead to spatial phobias. The author underscores that overcrowding is a key component creating a sense of discomfort.[307] These insights suggest that creating spatial comfort can involve strategic placement of elements below the observer's line of sight, away from primary viewing axes. Additionally, incorporating elements into the zone of spatial boundary planes (walls, floors, ceilings) can open up the space from within and simplify its form, contributing to a more comfortable environment.[308] (Figure 101)

5.2.2. Visual parameters

Color and light play crucial roles as visual parameters, contributing not only to visual comfort but also to spatial comfort significantly. Utilizing light and cool tones can create an illusion of expanded space within interiors, while darker and warmer tones tend to make spaces feel more enclosed and diminished.[309] Moreover, the orientation of natural light in a confined area affects the perception of spatiality; direct frontal lighting enhances the feeling of spaciousness compared to lateral lighting. This phenomenon not only extends the view outward but also creates an illusion of lengthening the internal space towards the source of light, a concept known as the "bright starting point" principle. Research conducted by authors Sibel and Pınar Ural underscores the crucial role of spatiality in achieving overall spatial comfort. While cool tones enhance the perception of spatiality, their findings highlight the importance of pastel colors, light intensity, and warmth of color in attaining a comfortable spatial experience.[310] (Figure 102)

305 Imamoglu, "The Relation Between Room Organization and Spaciousness."; Imamoglu, "Assesing the Spaciousness of Interiors."

306 Samuelson and Lindaur, "Perception, Evaluation and Performance in a Neat and Messy Room by High and Low Sensation Seekers."

307 Pop, *Arhitectură, percepție și frică*.

308 von Castell, Oberfeld and Hecht, "The Effect of Furnishing on Perceived Spatial Dimensions and Spaciousness of Interior Space."

309 Jaglarz, "Perception and Illusion in Interior Design."; Franz, "Space, color, and perceived qualities of indoor environments."; von Castell, Hecht and Oberfeld, "Bright Paint Makes Interior-Space Surfaces Appear Farther Away."

310 Ural and Ural, "Colour and Spatial Comfort in Architectural Context."

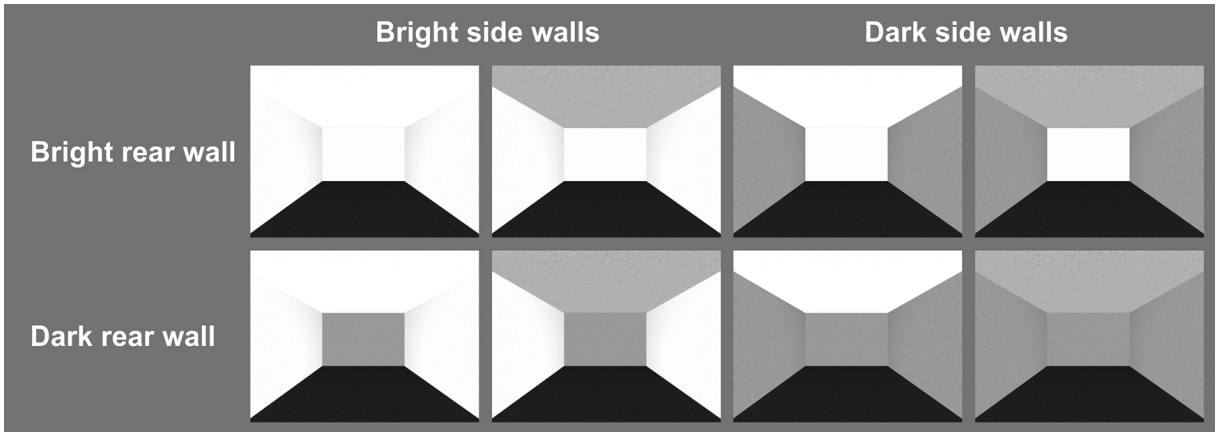


Figure 102 Impact of color and light tone on the experience of spatial comfort (Source: von Castell, Hecht and Oberfeld, "Bright Paint Makes Interior-Space Surfaces Appear Farther Away.")

5.2.3. Tactile parameters

Haptic parameters are especially crucial for individuals with visual impairments or blindness since they rely more on non-visual senses. The experience of spatial comfort through haptic parameters can be either active, during movement, or passive, during rest.[311] Haptic perception involves gathering information limited to the immediate surroundings, often referred to as "personal space," which is easily accessible. Therefore, discussions about spatial comfort mainly revolve around the immediate environment. Interestingly, what might be uncomfortable visually or physically, such as a cramped space, can sometimes be pleasant in terms of haptic experience. Key tactile parameters influencing the perception of spatial comfort include: 1) space security: ensuring the absence of irregular and sharp shapes or surfaces, allowing for freedom of movement; 2) spatial confinement: defining boundaries and helping individuals orient themselves within the space; 3) spatial memorability: enhancing comfort through regularity, orthogonality, and simplicity of the space. In the article "Exploring Haptic Design – The Blind Sense of Space" by Jasmien Herssens and Ann Heylighen, it is highlighted that blind individuals perceive space and spatiality in a distinct manner. Objects such as furniture and solid obstacles are perceived as spatial boundaries, potentially causing discomfort due to the risk of injury.[312] Optimal spatial design for blind individuals often involves using flat and slightly inclined surfaces as space boundaries, enhancing both memorability and safety. Conversely, expansive spaces wider than a few meters can be disorienting without clear orientation aids. For blind individuals, the absence of physical boundaries like walls can lead to feelings of being lost within a space.[313] This contrasts with concepts like flowing space and open-plan designs, which may promote spatial comfort for sighted individuals but can present challenges for those with visual impairments.To improve spatial memorability and navigation for blind individuals, textured surfaces and distinct shapes are employed,

311 Herssens and Heylighen, "Haptics and Vision in Architecture: Designing for More Senses."

312 Herssens and Heylighen, "Haptic Design Research – A Blind Sense of Space."

313 Vermeersch, *Less Vision, More Senses: Towards a More Multisensory Design Approach in Architecture.*

aiding in easier orientation within the environment.

In the study, parameters contributing to the attainment of spatial comfort were systematically categorized into distinct groups:

1) Physical Parameters:

– Distance of space boundaries,
– Space configuration,
– Space openness,
– Space shape;

2) Visual Parameters:

– Color potential in achieving spatiality,
– Light potential in achieving spatiality;

3) Tactile Parameters:

– Space security,
– Space confinement,
– Space memorability.

Based on the previous findings, it is clear that spatial comfort is the result of multiple parameters. Some of these parameters can be measured directly, such as the distance between space boundaries, space openness, or the shape of the space. Others are more conceptual and can only be observed as principles in action. Unlike other types of comfort like thermal or acoustic comfort, evaluating spatial comfort presents greater challenges because it heavily relies on individual perceptions of space by users. A more in-depth analysis reveals that comfort parameters are relative and can vary significantly among different individuals. Therefore, it is preferable to discuss a range or zone of spatial comfort rather than specific values. This is unlike thermal or acoustic comfort, where the comfort range is narrower and quantitatively measurable. It is crucial to acknowledge the qualitative diversity of these parameters. The experience of spatial comfort can vary significantly across different user groups, such as sighted individuals compared to visually impaired or blind individuals. What might be pleasant and comfortable for one group in a space may not necessarily translate to comfort for another group. For instance, while sighted individuals may prioritize the perception of spatiality as a key factor in achieving spatial comfort, blind individuals may place greater emphasis on tactile parameters that offer a sense of security within the space. These discernible parameters, which lend themselves to quantitative measurement, could be systematically investigated through diverse assessment scales applied to a broad participant base. Such endeavors could pave the way toward standardizing these parameters. Another avenue for exploration could involve employing the "Kansei engineering" method[314], which enables the evaluation of comfort experiences through the measurement of brain waves.[315]

It is important to emphasize that the parameters mentioned cannot solely guarantee the achievement of spatial comfort; instead, it entails a process of mutual complementarity and synesthesia involving multiple factors. Separating the sense of spatial comfort from other aspects of comfort experienced is often quite challenging because it necessitates a certain level of awareness regarding space characteristics. This can lead to situations where users are aware of feeling comfortable but may struggle to rationally pinpoint its cause. Consequently, the pleasantness of a space is commonly described in terms of it being "beautiful" or "pleasant."

5.3. Experience of territoriality

The concept of territoriality is widely acknowledged and manifests across various facets of human activities. It is commonly linked with the urge to demarcate spaces that individuals or groups utilize and safeguard. Science has

314 Kansei engineering, also known as emotional or affective engineering in Japanese as 'kansei kougaku,' is a methodology developed by Professor Mitsuo Nagamachi in 1970. It involves the measurement of brain waves and the translation of human impressions and emotions into specific parameters.

315 Watada, et al., "Realization of Comfortable Space Using Brainwave Signals."; Takagi, Watada and Yubazaki, "Realization of a Comfortable Space Based on Kansei Engineering."

delved into numerous parameters that define the extent of experiencing territoriality, encompassing aspects such as control, safety, personalization, and space protection.

The term "territoriality" primarily denotes a behavioral pattern observed in individuals or groups, rooted in the urge to exercise control over physical space, sometimes extending to objects or ideas.[316] This concept finds its origins and primary development in disciplines such as biology and sociology, where it is conceptualized as an "instinct for territorial possession" and "human species territoriality." These notions depict a spatial strategy adopted by individuals or groups to establish dominance, influence, and control over people, phenomena, relationships, and activities within a defined territory, place, or location.[317] According to Petar Bojanic, a notable aspect of territoriality is ownership, which implies the act of inclusion or exclusion of others. This presence or restriction of presence delineates the necessity for establishing boundaries to define the extent of territorial influence.[318]

Looking through the lens of political geography, Filip Tunjić posits that "space is not territory but rather an absolute natural fact, constituting the arena for territorial phenomena, processes, relations, and activities. [...] Understanding these aspects requires moving beyond the notion of "absolute space" and embracing the concept of "relative space," where distances between points are socially defined and vary based on numerous factors." Tunjić further defines territory as "space that is defended, conquered, or sought after in contrast to the demands of others," highlighting that the control of territory and/or access to it is a fundamental need and strategic requirement for all political entities, intertwined with security considerations across military, economic, cultural, ecological, and other realms.[319] Similarly, Petar Kurečić views territoriality from a broader perspective, suggesting that "territoriality can be seen as a strategy embraced by all states asserting sovereignty." Control over a specific area of space is a hallmark of sovereignty and signifies the establishment of authority over that territory through strategic territorial measures.[320] The research of Duško Vrban is particularly relevant to this discussion, as he delves into the role and significance of borders in the experience of territoriality within political geography. According to Vrban, territoriality is intricately linked with the concept of (state) borders, which not only delineate but also symbolize spatial distinctions. Vrban's analysis touches upon the historical evolution and understanding of natural borders, highlighting that contemporary borders primarily manifest as tangible physical barriers.[321] In addition to Vrban's insights, a wealth of other research works significantly contributes to our understanding of territoriality in the realms of geography and geopolitical relations.[322]

In the field of architecture, particularly within residential contexts, there exists a notable gap in research concerning the phenomenon of territoriality within individual or shared living spaces, despite its substantial influence on spatial and functional organization concepts. Iva Balgač, focusing on the

316 Edney, "Human Territoriality."

317 Ardrey, *The Territorial Imperative: A Personal Inquiry Into the Animal Origins of Property and Nations*; Gottmann, *The Significance of Territory*; Sack, *Human Territoriality: Its Theory and History*; Sack, "Human Territoriality: A Theory."

318 Bojanić, *Granica, znanje, žrtvovanje*.

319 Tunjić, „Međueuropa – paradigma političke geografije geopolitike. Na Zapadu ništa novo, na Istoku sve po starom," 893.

320 Kurečić, "Teritorijalnost i identitet u postmodernim geopolitičkim uvjetima: fundamentalne ili evolutivne promjene?", 238.

321 Vrban, „Granice kao interdisciplinarno pitanje: Teritorijalnost i identitet u prošlosti i sadašnjosti."

322 See: Johnston, "Territory and Territoriality in a Globalizing World."; Zorko, „Geopolitika i teritorijalnost."; Lyman, „Teritorijalnost kao globalna koncepcija."; etc.

Table 10 Characteristic interpretations of the term "territoriality"

Field	Територијалност ...	Аутори
Biology	... is an instinct for defending a given area.	Ardrey, 1966
Psychology, Sociology	... implies a pattern of behavior of an individual or group, based on the need to control owned physical space (sometimes an object or idea).	Edney, 1974
Geography	... is an attempt to influence or control actions, interactions, or access, with the aim of imposing control over a specific geographic area.	Sack, 1986
Philosophy	... involves inclusion and/or exclusion of others, i.e., the presence or restriction of someone's presence, indicating the necessity of some form of boundary.	Bojanić, 2009
	... is a form of communication between individuals.	Yilmaz, 2018
Political geography	... is ownership over a specific part of space as a condition of its sovereignty and establishment of control over that same space through territorial strategies.	Kurečić, 2014
	... is closely related to the concept of (national) borders, which create and represent differences in space.	Vrban, 2018
Architecture	... is the capacity or ability of the physical environment to create a sense of belonging to a specific neighborhood among residents, thereby increasing supervision of that area by the residents themselves.	Balgač, 2013
	... is directed, on one hand, at strengthening the sense of ownership among lawful users of the space, and on the other hand, at discouraging unlawful users, based on the idea that people instinctively defend the space they consider their property.	Hruškar, 2014
	... is the experience of owning space, up to the point where someone is allowed or expected to enter the living space, before the user gains a sense of compromised privacy.	Alfirević, Simonović Alfirević, 2019

defensibility of residential areas, defines territoriality as „the ability of the physical environment to foster a sense of belonging to a specific neighborhood among residents, thus encouraging increased vigilance and supervision by the residents themselves."[323] Balgač underscores that residents' establishment of territorial domains, whether in ownership or neighborhood contexts, is both a physical and social occurrence. According to Balgač, these domains can be demarcated physically, using walls, fences, etc., or they can be ephemeral, marked by presence, activities, or monitoring by occupants, which also serves as a clear signal to others. This research highlights the dual nature of territorial boundaries, emphasizing their potential to exist as both material and immaterial constructs. Petra Hruškar adds that territoriality aims not only to strengthen the sense of ownership among lawful occupants but also to deter unauthorized individuals, operating on the premise that people naturally defend spaces they perceive as their own. Enhancing clear boundaries between public and private spaces using physical elements bolsters the sense of ownership, consequently heightening the feeling of security.[324] Aleksandar Ristić and Vladimir Nešić delve into territoriality's role in crime prevention within residential environment design. They underscore how boundaries, regardless of size or fencing, prioritize private property, fostering a sense of ownership and protection. This, in turn, communicates to potential

323 Balgač, „Obranjivi prostor – Teorija napuštena s razlogom?", 74.

324 Hruškar, *Urbana sigurnost*.

intruders that the space is inhabited and defended.[325] Important contributions to this area of study come from Đorđe Alfirević and Sanja Simonović Alfirević, who explore territoriality's role in shaping co-living community spaces. Their work emphasizes that the fundamental parameter driving diverse coexistence concepts in shared spaces is the "experience of territoriality." This encompasses the level of tolerance among residents and their willingness to share spaces and resources with unfamiliar individuals.[326] (Table 10)

The above points suggest that territoriality involves a sense of possession or control over a defined space, stemming from ownership or vested interests in that specific area. The "boundary of territoriality" marks the extent to which someone is permitted or anticipated to access the space before the user feels their privacy is compromised.

5.3.1. Parameters influencing territoriality among people

The experience of territoriality among individuals is rooted in vested interests in a specific space, primarily stemming from ownership rights over a certain territory, yet it can also be driven by feelings of possessiveness and attachment to a place.[327] The emergence of territoriality hinges on several factors commonly outlined in the literature as follows: 1) safety, 2) control, 3) personalization, and 4) identification.[328] *Safety* - this factor plays a pivotal role in establishing psycho-physical security and a sense of protection for an individual or group within a space. It is heavily influenced by the visibility of the space, the presence of distinct boundaries, and the capacity to control access to the space. *Control* - this aspect denotes the defensibility of the space, encompassing the ability to regulate access and activities within the space. It pertains to the extent of influence one can exert over the space. *Personalization* - this factor involves the act of appropriating and marking a space through individual or group actions. It entails modifying the space according to one's preferences or inclinations, contributing to a sense of ownership. *Identification* - this factor reflects the connection of an individual or group with the space they inhabit or operate within. It signifies a positive relationship characterized by efforts toward the preservation and maintenance of the space.[329]

5.3.2. Spatial levels in human behavior

American anthropologist Edward Hall, in his seminal work "The Hidden Dimension" published in 1966, elucidated the nuanced behaviors and reactions exhibited by individuals within culturally defined personal spaces.[330] He delineated several distinct spatial levels that underpin human behavior and interactions with others. In his research, Hall identified:

1) Intimate distance,
2) Personal distance,
3) Social distance, and
4) Public distance.

Intimate space (or distance, as per Hall's classification) is defined as a distance of up to 45cm, reserved for extremely close individuals such as family members, partners, and trusted individuals. Approaching

325 Ristić i Nešić, „Teorija prevencije kriminala kroz dizajn okruženja."

326 Alfirević i Simonović Alfirević, "Significance of Territoriality in Spatial Organization of Co-Living Communities."

327 Scannell and Gifford, "The Psychology of Place Attachment."

328 Yu, *The Urban Courtyard Housing Form as a Response to Human Needs, Culture and Environment*; Gold, "Territoriality and Human Spatial Behaviour."; Yilmaz, "Human Territoriality: A Spatial Control Strategy."

329 Bogdanović Protić, *Definisanje modela revitalizacije slobodnih prostora kompleksa sa višespratnim stanovanjem u funkciji unapređenja kvaliteta života.*

330 Hall, *The Hidden Dimension*.

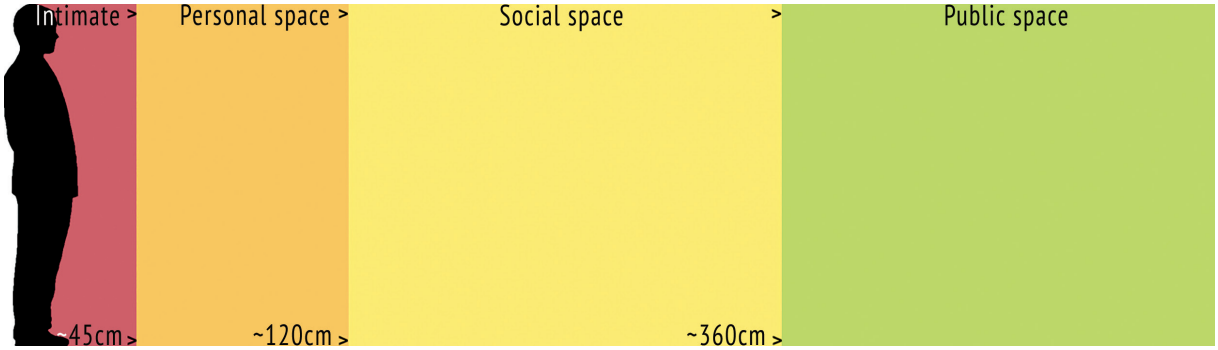


Figure 103 Spatial levels in human behavior according to E. Hall (Source: Authors' drawing)

someone within this close proximity whom we are not intimate with can be very unsettling. *Personal space* is defined within a distance range of 45-120cm, where we commonly interact with friends, shake hands, and are able to observe their body language and eye movements. *Social space* is defined within a distance range of 120-360cm, typically observed during interactions with less familiar or unknown individuals. During such interactions, people often speak louder, and eye contact becomes more necessary. *Public space* implies a distance beyond the boundary of 360cm, where there is no perceived loss of privacy or sense of threat due to proximity to other individuals.[331] While the existence of these spatial layers around each individual has been established in scientific research, it is crucial to note that the boundaries (45cm, 120cm, and 360cm) between these zones are subjective and can vary based on individual experiences. (Figure 103)

5.3.3. Territoriality in residential space

The mentioned spatial layers denote a distinct experience of territoriality in an individual, stemming from varying degrees of perceived privacy intrusion due to proximity to another person. On a larger scale, similar principles govern spatial layers concerning a group of individuals within a specific relative space in relation to others. Hence, we can identify the phenomenon of territoriality in various contexts: 1) within residential communities, 2) inside residential buildings, and 3) within individual residential units.

When examining open spaces within multi-family housing, Ivana Bogdanović Protić delineates specific zones that delineate the experience of territoriality among users.[332] In her research, the author identifies four territorial levels within the structure of residential spaces:

1) Private area - a zone not accessible to the public, such as an apartment restricted to residents (family and their friends). Residents bear responsibility for its upkeep and are governed by a single household.

2) Semi-private area - an area with restricted access, such as atriums, rooftop terraces, and staircases within the building. While open to building visitors, it is primarily utilized by building residents.

3) Semi-public area - spaces like courtyards, playgrounds, gardens, vestibules, and building hallways. Although there are usage restrictions,

331 Hall, *The Hidden Dimension*; Efran and Cheyne, "Shared Space: The Co-Operative Control of Spatial Areas by Two Interacting Individuals."

332 Bogdanović Protić, *Definisanje modela revitalizacije slobodnih prostora kompleksa sa višespratnim stanovanjem u funkciji unapređenja kvaliteta života.*

they remain accessible to all. These areas are open to residents of the residential complex as well as the broader community, with a lower level of control.

4) Public areas - zones accessible to the general public for various purposes, such as city squares, parks, and similar spaces.

The presence of territorial boundaries within residential spaces, often described as a "social filter," arises from the inherent sense of territoriality that individuals may feel toward others within a shared environment. This phenomenon occurs across distinct levels, including intimate space, personal space, social space, and public space. These zones delineate varying degrees of comfort or unease regarding interactions with others within the given space. Their significance and boundaries are subjective, shaped by cultural norms and individual personalities.[333]

5.3.3.1. Territoriality of a residential community

The term "residential community" is understood in diverse ways within literature. Specifically, it can refer narrowly to an organization encompassing all owners of individual units within a residential or mixed-use building.[334] More broadly, it may signify an inseparable and unalterable territorial entity, such as a collection of multiple residential structures with distinct characteristics and identity. Larger spatial entities, like settlements, arise from transportation connections between multiple residential communities.[335] For the purposes of this study, a broader interpretation of the residential community concept will be adopted to differentiate it in architectural and urbanistic contexts from a residential building as a legal form of a residents' community.

The territory of a residential community is demarcated by its block boundaries. As outlined by Milica Milojević, a fundamental aspect of territoriality within such a community is the control and regulation of access. This control can manifest not only through physical barriers like gates, fences, or walls but also through the design and utilization of surrounding public spaces. Typically, the transportation network plays a key role in defining the boundaries of the community.[336] The experience of territoriality in residential environments is inherently present, varying in its expression based on architectural clarity and the degree of demarcation. Clear and distinct boundaries enhance residents' identification with their community space. Contrasting examples such as Casa de las Flores (Secundino Zuazo, 1932) in Madrid and a residential block in Wrocław (Affordable Housing, Arch_it piotr zybura, 2017) reveal differences in block enclosure and boundary definition, reflecting diverse cultural, social, and economic contexts. (Figure 104)

According to research conducted by Huang, Mori, and Nomura, notable distinctions in territorial experience arise between open and closed urban blocks. Their study, focusing on two distinct blocks in Changchun, China, reveals that residents in closed urban blocks tend to have a more pronounced sense of territoriality compared to those in open blocks, where boundaries are less defined and clear.[337] Similarly, Noshin, Adham, and Ul-Haq, in their study titled "Human Territoriality in Closed Communities," reinforce these findings. They highlight that residents within closed

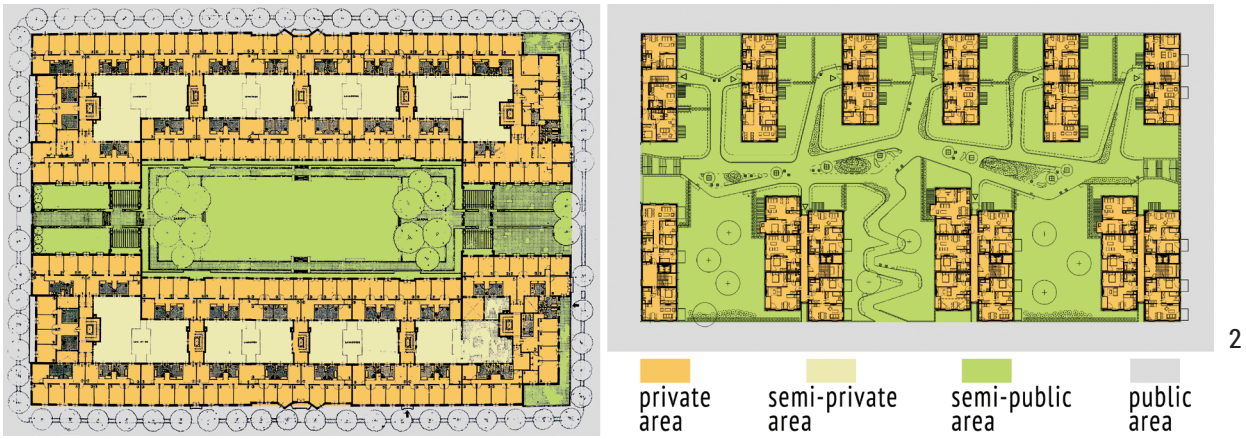
333 Sorokowska, Sorokowski and Hilpert, "Preferred Interpersonal Distances: A Global Comparison."; Strube and Werner, "Interpersonal Distance and Personal Space: A Conceptual and Methodological Note."; Gifford, "The Experience of Personal Space: Perception of Interpersonal Distance."

334 ***, „Zakon o stanovanju i održavanju zgrada."

335 Novak, *Stambena zajednica – Porodica i domaćinstvo 1958*; Petrović i Milojević, „Reafirmacija susedstva kroz prostorne prakse regulisanja poželjne prostorne i društvene distanciranosti."

336 Milojević, *Plan susedstva – Norme prostorne i društvene distanciranosti.*

337 Huang, Mori and Nomura, "Territorial Cognition, Behavior, and Space of Residents: A Comparative Study of Territoriality Between Open and Gated Housing Blocks; a Case Study of Changchun, China."



1 2

Figure 104 Experience of territorial levels within the structure of a residential community: a) closed block (Casa de las Flores, Madrid, Secundino Zuazo, 1932) and 2) open block (Affordable Housing, Wroclaw, Aarch_it piotr zybura, 2017) (Source: Authors' archive)

communities, characterized by fencing and solid boundaries, perceive a sense of an "extended home" that encompasses the entire block. This perception is fostered by communal use of open spaces, which significantly contribute to social integration within the residential community.[338] The research underscores that residents' dissatisfaction with open spaces, often due to neglect and disorderliness in communal areas, can lead to a diminished sense of identity with the residential environment and community.[339]

5.3.3.2. Territoriality of residential buildings

A home transcends mere physicality, encompassing not just a house or an apartment but also the emotional investment an individual puts into it. Douglas Porteous argues that a home represents the "core of territorial experience," offering identity, protection, and stimulation.[340] Territoriality within a residential building can be as intricate as within a residential community. The internal structure of multifamily buildings typically comprises: 1) private spaces, 2) semi-private spaces, and 3) semi-public spaces.[341] *Private spaces* encompass individual residential units such as apartments or houses, each with its internal territorial demarcation. *Semi-private spaces* comprise shared areas like corridors and communal spaces within the building that residents collectively use. On the other hand, *semi-public spaces* include common areas like entrance halls and courtyards utilized by all residents as well as non-residents of the building or complex. A prime example illustrating distinct territorial levels within a residential building is found in the architectural typology of a double-loaded corridor or an H-shaped building. Unlike other multi-family housing layouts characterized by private and semi-private zones, double-loaded corridors introduce a unique feature: an interstitial space between two corridors. This space, while part of the building's interior, is often accessible to external visitors, delineating a nuanced boundary between public and private realms. (Figure 105)

338 Nosheen, Ajmal and Ul-Haque, "Human Territoriality in Gated Communities."

339 Bogdanović Protić, *Definisanje modela revitalizacije slobodnih prostora kompleksa sa višespratnim stanovanjem u funkciji unapređenja kvaliteta života.*

340 Porteous, "Home: The Territorial Core."

341 Barclay, *Territoriality in Public Housing.*

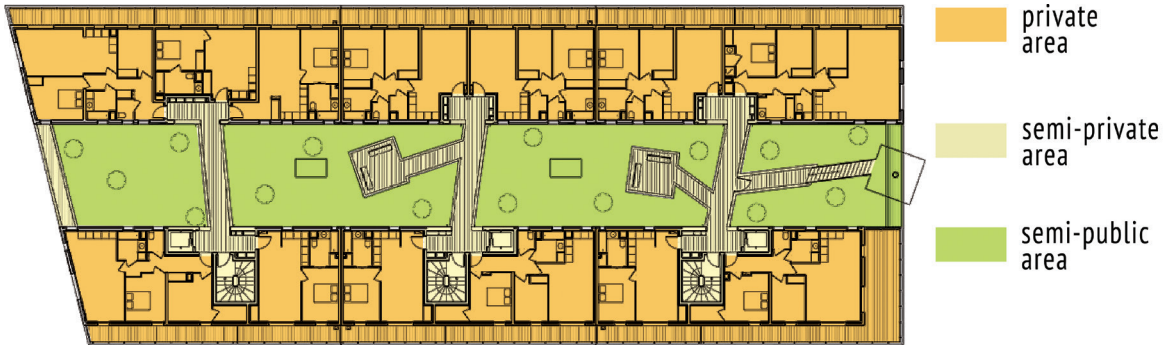


Figure 105 The experience of territorial levels within the structure of a residential object (Redline, La Seyne-sur-Mer, Pietri Architectes, 2014) (Source: Authors' archive)

In this context, it is crucial to highlight an insight shared by Oscar Newman, who observed in his research that as the number of households sharing a building's space increases, individuals may perceive fewer rights over that space, resulting in a diminished sense of territoriality to some extent.[342] The demarcations between different territorial levels within residential structures are typically clearly defined and often physical, such as walls, doors, and fences. The first boundary delineates the private spaces of individual residential units from shared (semi-private) spaces in a multi-unit building, as well as between private spaces within the building itself; this boundary is known as the "privacy boundary." It signifies the extent of ownership by each household. The second boundary, termed the "communal boundary," separates shared (semi-private) spaces from public spaces or semi-public areas. This boundary indicates the limit of residents' territorial claims due to the communal use and collective investment in maintaining these spaces. The third boundary, found in certain multi-unit housing configurations like double-loaded corridors, distinguishes between semi-public and public spaces; it's known as the "public boundary." This boundary regulates access for outsiders and governs the use of semi-public areas within the building. In cases where these boundaries are not clearly articulated or lack material definition, conflicts can arise between residents and visitors, leading to potential security concerns and issues with unwanted activities.[343]

5.3.3.3. Territoriality of residential unit

Within a residential unit, whether it is a house or an apartment, there are distinct levels of territoriality that emerge based on both physical boundaries and the dynamics of user-space relationships. The primary level is defined by the physical boundary of the residential unit, delineating the private space from the surrounding public area—a boundary often referred to as the "ownership boundary," representing the domain of the household. The second level of territoriality arises in scenarios where there's a clear distinction between social areas and private spaces within the residential unit, establishing what can be termed as the "hospitality boundary" for visitors. This boundary marks the transition point where guests are typically welcomed, especially if they are not intimately familiar with the household. Typically, in complex residential layouts, this boundary encompasses family social

342 Newman, *Creating Defensible Space*.

343 The terms 'boundary of ownership,' 'boundary of community,' and 'boundary of publicness' are employed contextually in this study to denote the characteristics of the examined boundaries between various territorial levels.

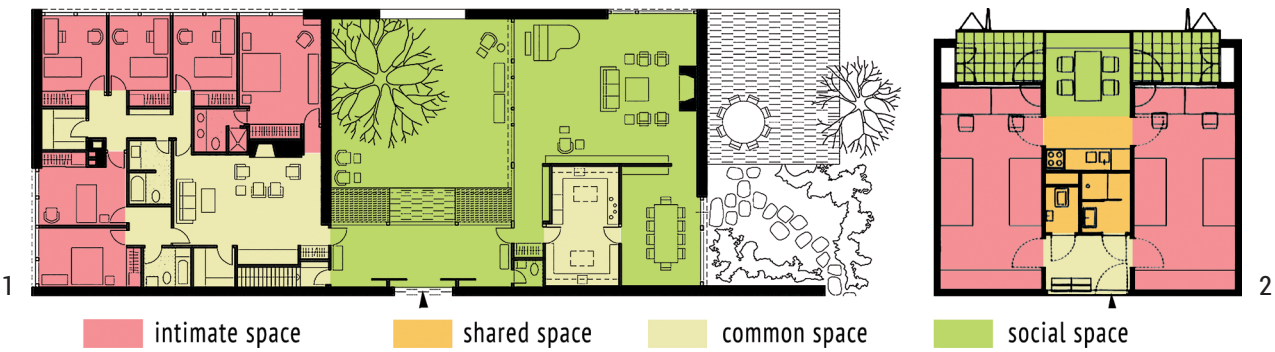


Figure 106 Experience of territorial levels in the structure of residential units: 1) Family housing (Hooper House I, Baltimore, Marcel Breuer, 1960) and 2) Co-living housing (Student Housing Poljane, Ljubljana, Bevk Perovic, 2006) (Source: Authors' archive)

areas such as the living room, lounge, or study, and less commonly, areas like the dining room or kitchen. The third level of territoriality is characterized by physical boundaries that separate intimate or familial spaces, establishing the "privacy boundary" within the household, defining spaces where family or household members can expect privacy and personal space. (Figure 106) In shared living arrangements like co-living spaces, a unique type of boundary known as the "sharing boundary" emerges. This boundary distinguishes between intimate spaces and shared areas such as kitchens and bathrooms, which residents are particularly sensitive about due to considerations of hygiene and maintenance frequency.[344]

Research by Rachel Seba and Arza Churchman delves into the nuances of territoriality within family residential spaces. The authors propose a nuanced classification of territorial zones within a household: 1) *Individual spaces* - these are areas exclusively owned by one person, where they exert the highest level of control, 2) *Shared spaces* - these areas are shared among a subgroup of the household, such as parents or shared rooms for children, 3) *Public spaces* - these spaces belong to the entire family and are commonly used by all members, 4) *Spaces of authority* - While these spaces belong to the entire family, they are typically associated with the predominant use by a specific individual (e.g., the kitchen primarily used by the mother).[345] In their study, the authors did not delve into the physical boundaries of territoriality, but they noted that each household member is aware of the ownership of spaces and the transition points between different zones. This observation is crucial as it highlights the intricate and interconnected nature of territorial levels within a residential unit, which go beyond mere physical demarcations. Additionally, there exist numerous non-material boundaries of territoriality that delineate micro-zones of interest and control among household members. Furthermore, the experience of territoriality can also be observed in the arrangement and use of individual furniture elements within these spaces.

Upon reviewing the research findings thus far, it becomes apparent that territoriality in residential settings is influenced by two types of boundaries:

344 Alfirević i Simonović Alfirević, "Significance of Territoriality in Spatial Organization of Co-Living Communities."

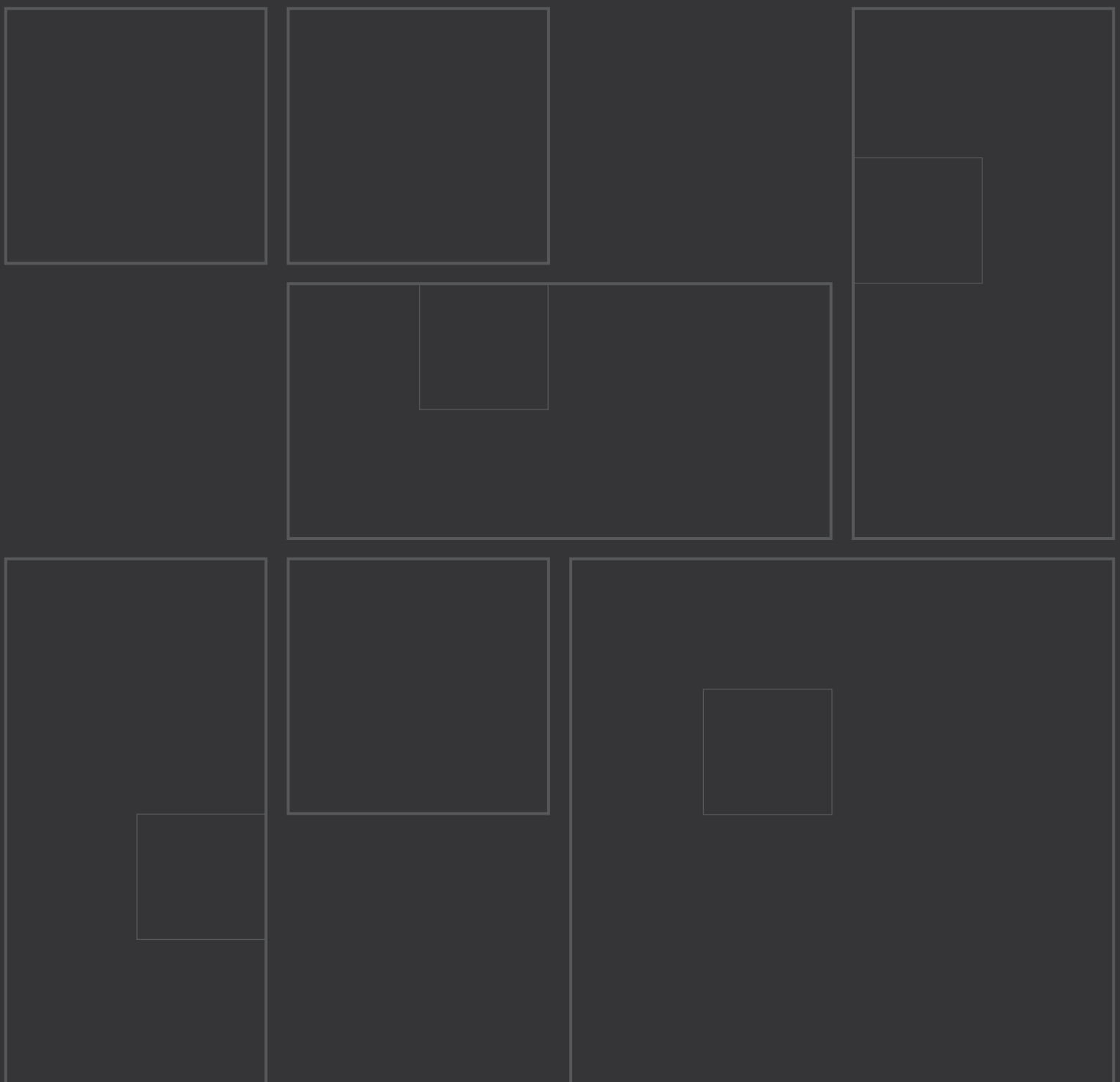
345 Sebba and Churchman, "Territories and Territoriality in the Home."

material and non-material. These boundaries mark the transitions between specific zones of interest or areas with distinct territorial characteristics. Through a deductive analysis of typical territorial levels in housing—such as residential communities, residential units, and individual living spaces—several distinct boundaries of territoriality have been identified, categorized for clarity as follows: 1) Boundary of intimacy, 2) Boundary of sharing, 3) Boundary of hospitality, 4) Boundary of privacy, 5) Boundary of community, and 6) Boundary of publicness. (Table 11)

The hierarchical arrangement of boundaries across different territorial levels can be observed in the provided table, reflecting their presence in various living arrangements. These boundaries manifest in both material and immaterial forms, depending on the need for control between specific user types. Material boundaries typically involve physical barriers such as walls, fences, ramps, elevators, screens, and flexible dividers, while immaterial boundaries rely on urban markers like graffiti, signs, sounds, music, lighting, user presence, and so on. The hierarchy of territorial boundaries is structured based on the level of access permitted before an individual senses a breach of privacy. Lower levels of territoriality, often within family settings, tend to be more flexible, leading to shared and common spaces. In contrast, higher levels of territoriality feature firmer boundaries, as they are meant to deter access by less familiar or completely unknown individuals. This distinction is crucial as it influences the perceived sense of security and ownership among individuals or groups within these spaces.

Table 11 Systematization of territorial boundaries in housing

Level	Boundary name	Characteristics
1	Boundary of intimacy	Distinguishes individual spaces or individual and shared spaces within a residential unit. It is often material due to the necessary achievement of comfort in living space.
2	Boundary of sharing	Distinguishes shared spaces, shared from individual or shared from common spaces. Boundaries can be both material and immaterial, depending on the situation and application.
3	Boundary of hospitality	Distinguishes individual, shared, and common spaces from social spaces where visitors are received. Boundaries can be both material and immaterial, depending on the situation and application.
4	Boundary of privacy	Distinguishes spaces of the residential unit from external semi-private spaces. Boundaries are mostly material to preserve privacy within the household.
5	Boundary of community	Distinguishes semi-private from semi-public spaces. Boundaries can be both material and immaterial, depending on the situation and application.
6	Boundary of publicity	Distinguishes semi-private from public spaces or semi-public from public spaces. This concerns the ultimate extent of territorial experience towards public space. Boundaries can be both material and immaterial, depending on the situation and application.



VI CONCLUSION

The subject of configuring residential space stands as one of the universal themes in architecture, given its direct correlation with the design, utilization, arrangement, and shaping of living spaces. Despite its significance, the exploration of space configuration within architecture remains somewhat limited, making this study a notable advancement in architectural theory and practice. This book systematically presents and scrutinizes characteristic design principles essential for adequately structuring and organizing residential spaces. These principles are delineated across several chapters based on hierarchy and sequence. They range from foundational principles, crucial for achieving basic functionality within residential spaces, to those that contribute to enhancing the quality, structure, and organization of these spaces. For instance, perceptual principles, which are relatively subjective as they hinge significantly on the user's personal experiences, fall into this latter category.

It is worth highlighting that while the principles are organized into distinct categories or chapters, they can also be classified in alternative ways due to their varied cause-and-effect relationships. For instance, when examining the openness of space, which includes principles like open plan, enfilade, all-in-one space, and openness to the environment, these principles can be viewed as organizational principles as demonstrated in the book. However, they can also be considered perceptual principles because they influence, to some degree, the experience of residential space. Similarly, the principle of multiplicity of functions can act as both a cause and a consequence of space configuration. In this context, this study and its systematic presentation can be seen more as a proposal rather than a definitive classification. This approach allows room for future researchers to reassess our findings critically, with the hope of validating the results we have achieved.

Upon reviewing the objectives of this research, we can affirm that they have been successfully met. The theoretical aspect has been addressed by defining the term "space configuration" and establishing its connection to terms such as structure and organization of space. Furthermore, a systematic categorization of distinctive design principles has been carried out to facilitate the achievement of residential space configuration. It has been emphasized that space configuration encompasses functional, structural, organizational, and perceptual aspects of space design, thereby validating the fundamental hypothesis.

While certain aspects and topics covered in this book have been explored in previous studies and scientific papers, there has been no prior research that has systematically linked these aspects to achieve a comprehensive systematization of design principles. Therefore, this book offers a distinct contribution by providing a clear explanation regarding the relationship between these aspects to achieve space configuration. It addresses the set goals and confirms the hypothesis that space configuration is the result of interconnected functional, structural, organizational, and perceptual principles that complement each other, culminating in a higher-order concept recognized in the study as space configuration.

It is important to highlight that the exploration of space configuration is not exhaustive within this book, leaving

numerous avenues for further advancement. Empirical research could help pinpoint parameters contributing to the "multiplicity index," thus contributing to a more objective assessment of the utility of residential space. Moreover, delving into research that refines the typology and characteristics of multipurpose spaces would be highly valuable. Future research directions could extend towards empirically verifying and systematizing territoriality boundaries across various human activities. Additionally, there is potential for analyzing territoriality experiences within a broader spectrum of residential patterns. The clear articulation of terms and systematization of fundamental principles provide a foundational framework for research aimed at standardizing principles and potentially incorporating them into regulatory frameworks. Conversely, the structured principles and parameters outlined in this work could serve as a basis for formulating project tasks in collaboration with end-users seeking to design residential spaces tailored to specific hierarchical needs. Research in this field could also focus on uncovering and analyzing new principles, or at least those not covered in this book, such as the readability or expressiveness of residential spaces, the typology of enfilades and circular connections, the experience of territoriality in shared living concepts, and more. Additionally, efforts can be made towards their systematization within the proposed framework or a new system of relations.

The significance of this topic is primarily underscored by the assertion that for a high-quality arrangement and design of residential spaces, it is crucial to consider the application of principles and their interrelationships as elucidated in the book. Hence, it is insufficient to merely create a functional space for it to be deemed pleasant or well-structured. Conversely, a pleasant residential space does not necessarily guarantee functionality or good organization. A comprehensive assessment of residential spaces should encompass the aspects discussed in this book, or at least most of them. Thus, it is imperative to explore the possibilities of their practical application.

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Summary

The configuration of living space is one of the universal topics in architecture, as it is most directly linked to the design and use of the living space, its arrangement and shaping. The term itself has been used in various fields of human activity. In most cases, and depending on the field in which it is applied, it is identified with the term "organization" when it is equated with the structure, composition or arrangement of elements in a system. When applied in the domain of architecture, configuration of space most often implies arrangement of parts or elements in a certain form, space or composition. However, the term "configuration of space" includes not only structural aspects (composition and relations of elements), but also organizational ones (arrangement and pattern of restrictions), as well as certain perceptual (aesthetic) aspects, related to the experience of space, which indicates that a certain domain of meaning is not covered by the terms structure and organization, but which nevertheless constitutes a configuration. This is why this monograph presents configuration of space as a higher-order term, which includes the application of functional, structural, organizational and perceptual principles aiming to achieve its complete aesthetic shaping. The book systematically presents and analyzes the characteristic design principles that enable adequate living space configuration. The principles are grouped into several chapters, according to their hierarchy and order, from the most general and fundamental, without which it is not possible to achieve functionality of the living space, to those that form the improvement of a quality structure and organization, such as perceptual principles, which are relative because they largely depend on personal experience of a user.

Le résumé

La configuration de l'espace de vie est l'un des sujets universels en architecture, car elle est directement liée à la conception et à l'utilisation de l'espace de vie, à son agencement et à sa mise en forme. Le terme lui-même a été utilisé dans divers domaines de l'activité humaine. Dans la plupart des cas, et en fonction du domaine dans lequel il est appliqué, il est identifié au terme « organisation » lorsqu'il est assimilé à la structure, à la composition ou à l'agencement des éléments dans un système. Lorsqu'il est appliqué dans le domaine de l'architecture, la configuration de l'espace implique le plus souvent l'agencement des parties ou des éléments dans une certaine forme, espace ou composition. Cependant, le terme « configuration de l'espace » inclut non seulement des aspects structurels (composition et relations des éléments), mais également des aspects organisationnels (agencement et modèle des restrictions), ainsi que certains aspects perceptuels (esthétiques), liés à l'expérience de l'espace, ce qui indique qu'un certain domaine de signification n'est pas couvert par les termes structure et organisation, mais qui constitue néanmoins une configuration. C'est pourquoi cette monographie présente la configuration de l'espace comme un terme de niveau supérieur, qui inclut l'application des principes fonctionnels, structurels, organisationnels et perceptuels dans le but d'atteindre une mise en forme esthétique complète. Le livre présente et analyse de manière systématique les principes de conception caractéristiques qui permettent une configuration adéquate de l'espace de vie. Les principes sont regroupés en plusieurs chapitres, selon leur hiérarchie et leur ordre, des plus généraux et fondamentaux, sans lesquels il n'est pas possible d'atteindre la fonctionnalité de l'espace de vie, à ceux qui forment l'amélioration d'une structure et d'une organisation de qualité, tels que les principes perceptuels, qui sont relatifs car ils dépendent en grande partie de l'expérience personnelle de l'utilisateur.

Index of terms

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Đorđe I. Alfirević was born in 1976 in Belgrade. He obtained his Bachelor's degree in 2002, Master's degree in 2010, and Ph.D. in 2015 from University of Belgrade - Faculty of Architecture. He began his professional career at the Institute of Architecture and Urban & Spatial Planning of Serbia in Belgrade, as a Research Fellow (Ministry of Science and Technological Development of the Republic of Serbia) from 2000 to 2006. He was granted the status of independent artist and membership in the Association of Applied Arts and Designers of Serbia (ULUPUDS) in 2011, after which he established an independent design practice within Alfirević Studio. Since 2020, he has been employed at the Faculty of Contemporary Arts in Belgrade as an Associate Professor.

He has received several prestigious awards and recognitions, including the Borba Award for Architecture in 2001 (student category), the University of Belgrade Award for Best Research Project in 2000, ULUPUDS Annual Awards for 2012 and 2020, Alexander Shaletić Award in 2022, among others. He has participated in numerous domestic and international architectural competitions, many of which have been awarded and published. Besides architecture, he is actively involved in artistic creation and education in the fields of architecture and arts. His artistic works have been exhibited in several group and solo exhibitions.

Sanja R. Simonović Alfirević was born in 1981 in Belgrade. She graduated in 2006 and obtained her Ph.D. in 2016 from the Faculty of Architecture, University of Belgrade. In 2006, she was named the student of the generation at the Faculty of Architecture, University of Belgrade. She has eceived “Novosti Award” for Architecture (student category) in 2006, as well as “Sveti Sava” Award for the best diploma project in the same year. From 2005 to 2007, she was engaged at the Faculty of Architecture, University of Belgrade, as a teaching assistant.

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728

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