

TOWARDS FLEXIBLE HOUSING: BASIC DESIGN PRINCIPLES

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Abstract. *In times of radical social transformations, the demand for flexibility of space can be identified as one of the strategic priorities of maintaining the urban environment. In the context of social, economic and environmental sustainability, housing must imply an integrated ability to respond to programme changes, which can be achieved through the concept of flexibility. By identifying and applying certain design principles, it is possible to prevent the problem of functional obsolescence and unsuitability of the living environment that modern cities are facing. The apartment as an immediate living environment is the most direct indicator of the degree of adaptability of the physical surrounding to modern human needs. The analysis of basic design principles, using an example of flexible apartment, examines the spatial correlations and laws of the relationship between elements of the plan, which provides the basis for the authors to draw the conclusions about the reality of applying this concept in practice.*

Key words: *apartment, housing, flexibility, design principles, sustainability*

1. INTRODUCTION

Progressive socio-economic development, advances in information and communication technologies, the state and conditions of the living environment create a climate for constant and continuous changes, setting new conditions and requirements in the field of architecture. The evolution of housing leads to new conceptual solutions and new standards and principles of design. Programme changes in the field of housing are conditioned by numerous phenomena occurring in the modern society, among which are particularly noteworthy the accelerated population growth, emphasized social diversity, transformation of household typology, tendency of cohabitation of non-residential and residential functions, etc.

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In the existing urban areas, the number of abandoned buildings that are in a state of devastation and obsolescence is growing. The problem is further complicated by the fact that in the age of progressive growth of the world population, upgrading the housing environment in already defined and densely populated urban patterns is recognized as an imperative measure of sustainability. The sustainability of the urban environment in the conditions of progressive social development requires strengthening the functional immunity of all urban layers, from basic constitutive elements to the complex formations of the dynamic spatial system. Physical and functional adaptability to technological, environmental, economic and social trends requires the definition of sustainable housing models that will respond to programme and content modifications. Housing that actively corresponds to the continuous changes in society is therefore required to conceptualize in accordance with the general principles of flexibility, which within the appropriate spatial framework enable the acceptance and functioning of the different housing concepts.

Flexibility represents a political and social imperative, which is based on people's differences rather than on their similarities. These differences are recognized in informal patterns of space exploitation that flexibility formalizes through its principles [1]. Decisions made at the earliest stage of design, which relate to the spatial and functional characteristics of the plan, largely determine the course and potential modalities of housing exploitation. The main goal of the research is to improve the quality of living space by affirming conceptual models of flexibility through its basic design principles. In accordance with the basic goal and the selected methodology, the paper defines the apartment as theoretical and physical framework of the research, along with an analysis of human needs issue within it. The main starting point in the research is the assumption that implementation of the certain design principles ultimately increases the level of plan flexibility. Perceiving and understanding the interdependence of specific physical aspects is a necessary precondition for optimizing the space exploitation. In this regard, appropriate spatial correlations formulated through the basic principles of flexibility are identified. After systematization and formulation of the principles, their interdependence is examined and the possibilities of implementing this concept in practice are evaluated.

2. THE APARTMENT AS A FLEXIBLE FRAMEWORK OF MODERN SOCIETY

The apartment represents a basic physical, but also psychological framework for satisfying complex human needs that it incorporates and links to its multi-valued functions [2]. The relationship between human and the environment should be perceived as a two-way process, in which the exploitation mode represents the basic determinant of this relationship and the source of knowledge about the housing needs and peculiarities of human nature. This relationship, usually called "the apartment exploitation", is in fact not exclusively of an exploitative nature. Namely, humans use a living space by giving it signs of their engaged presence [3]. Satisfaction of housing needs is the basic measure of an apartment use value. The design quality depends on the extent to which the apartment can respond to the dynamics and diversity of life processes within it. By correlation of numerous factors, created housing environment puts a dweller in a role of an active participant or passive observer, on the basis of which the measure of "humanization of space" [4], i.e., "visibility" of users in space is determined.

The diversity and complexity of housing functions stems from the individual developmental variation within different household models. Changes in the modern way of living, under the dominant influence of advanced information technologies and current movements of globalization and sustainability, transform the classical perception of the family and affect the development of new household typologies. Along with the globalization process, movements of liberalization and individualization are also developing, transforming inherited traditional and dogmatic values within the concept of modern society. Social movements and the evolutionary progress of society create demand for reconceptualization of contemporary housing and research of new developmental models and housing typologies. The range of individual and common needs is constantly getting more complicated, and thus the potential patterns of space exploitation. The traditional monothematic family, which once represented the dominant unit of society, is now becoming just one of many typological forms of households. The dominant primacy of the individual over the collective, in the current conditions defined by the modern society creates the programme diversity on the housing market. Greater efficiency and mobility of information technology transform the classic housing concept, requiring its programme redefinition. The dynamism of life and the technological revolution initiated new tendencies in housing development, where flexible mechanisms are the basic instrument of amortization of programme changes. The unpredictability and dynamism of life circumstances, the weakening of socially predetermined roles, traditional and marital norms, the postponement of starting the family, the expression of the individual over the collective lead to the gradual replacement of the institution of marriage with alternative forms of single life and living together in cohabitation. The increasing degree of tolerance and freedom in self-decision and self-determination, as well as the weakening of previous ties with tradition and inherited social values, result in structural diversity and heterogenization of lifestyles.

The living environment should in the most appropriate way respond to the socio-psychological specificities of human needs. A rigid and unadaptable housing can leave serious consequences on personal identity and cause psychological and sociological conflicts in a family or non-family group. Flexibility of an apartment is a dynamic category that, given the complexity of human needs, can significantly improve the exploitation potentials [5]. In this regard, it is necessary to define the basic design principles which will support the concept of flexibility and its dynamic performance.

3. ARCHITECTURAL PRINCIPLES OF FLEXIBILITY

Considering the results of previous research on the topic of flexibility [2], the basic design principles are presented in seven major categories. These principles which can serve as recommendations for improving the methodology of architectural design can be expressed and classified as follows:

1. principle of stratification
2. principle of coherent grouping
3. principle of polyvalence and neutrality
4. principle of openness
5. principle of modularity
6. principle of division and integration
7. principle of spatial reserves.

Figure 1 shows an example of a flexible apartment within Neuwil residential development in Wohlen (Switzerland) designed by Metron-Architekten AG. The basic idea of the designers was that the apartment, owing to its flexible potentials in the open plan, responds to the changing needs of one family group, i.e., the changing lifestyle of future generations. The centrally positioned technical core contains a sanitary block, a kitchen and a staircase, and only its function and position are predefined. The use and arrangement of surrounding space is not predetermined, but the tenants are left with the possibility to organize it individually. As the convenience of orientation, quality and size of the space facing the east and west facades are almost identical, it is possible to create different spatial arrangements by exchanging the functions. As part of the project, the architects also prepared the brochure in which they presented the potentials of space flexibility through appropriate 2D and 3D drawings. Thus, among other, the possible position of the partitions in the modular grid of 30 cm is indicated in analyzed apartment. As this apartment contains all the previously mentioned principles, they will be individually presented through the schematic drawings by the authors of this paper.

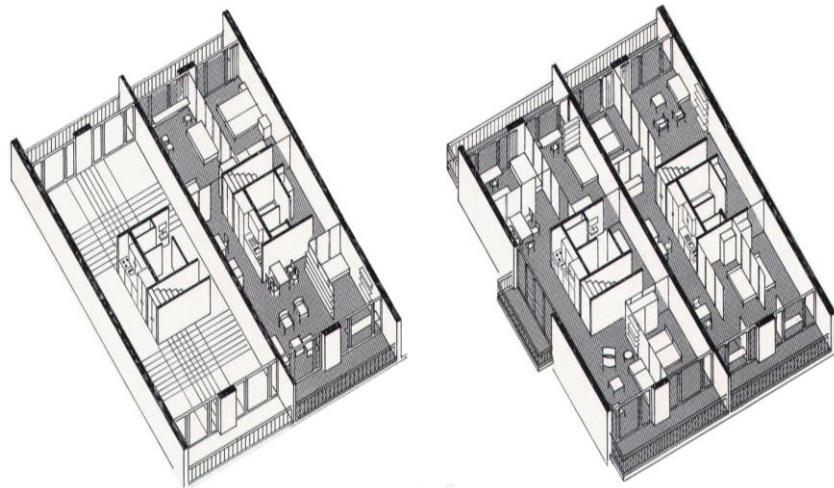


Fig. 1 The example of flexible apartment, Neuwil, Switzerland, Metron-Architekten AG (M. Pestalozzi, “Flexibilitätsexperiment im Freiamt”, 29. August 2016, [Digital image], <https://www.swiss-architects.com/de/architecture-news/meldungen/flexibilitatsexperiment-im-freiamt>)

3.1. Principle of stratification

Differentiation of spatial characteristics based on their determination in the plan is the initial step in conceptualization of a flexible housing model (see Fig. 2). Systematic spatial decomposition into static and dynamic components or, according to the classification of relevant authors, into “structure and infill” [6], i.e., “frame and generic space” [7], actually means that in the initial stage of design it is necessary to define a constitutive platform that will, in a later phase, adequately accept upgrading and variability of the system. In this regard, a thorough analysis of the aspects that permanently and irreversibly define the morphology and modalities of space exploitation is extremely important for the study of flexibility.

Immutable, fixed plan determinants include all constructive, dispositional and installation components that are permanently defined in the plan. Variable aspects represent spatial characteristics in free interpretation which are, in fact, direct indicators of the achieved degree of flexibility.



Fig. 2 The principle of stratification with designated “frame and generic space”

3.2. Principle of coherent grouping

The way of structuring determinants in the plan is one of the important factors of flexibility. The grouping of related functions into residential zones is replaced by the grouping of coherent contents and elements of the plan according to the principle of permanence and variability in space-time frameworks. As the installation blocks and bearing elements of the structural system represent the most inflexible parts, it is necessary to thoroughly consider the possibilities of their grouping in the plan (see Fig. 3). By integrating the determinants into a meaningful grouping, the surrounding space is relieved of physical constraints, thus achieving a greater degree of free zone variability. If the construction design envisages the positioning of the bearing elements within the plan, it is desirable to position the installation blocks in the immediate vicinity of these elements, in order to clearly separate the so-called “frame” of “generic space”. It is also desirable to group auxiliary rooms that do not require natural lighting and ventilation within this zone. Coherence and compactness instead of the fragmented concept of determinants in the plan is, therefore, one of the principles of flexibility.

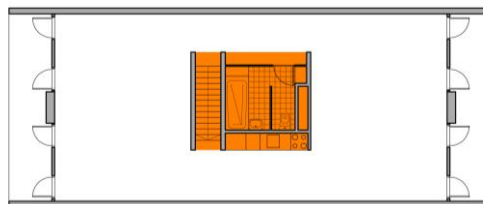


Fig. 3 The principle of coherent grouping with designated core of determinants

3.3. Principle of polyvalence and neutrality

Universality of space organization represents a response to the unpredictability and uncertainty of programme contents that housing unit accepts over time. The creation of neutral spaces that correspond to multiple purposes and functions is one of the principles that leads to the prolonged housing exploitation (see Fig. 4). The concept of undefined

and polyvalent space transcends conventional housing models, in which the functional and spatial differentiation of contents is conducted according to a strict schematic pattern. Unlike the classical system of rooms of predetermined function, the advanced programme concept defines typical units of approximately same size and dimensions, which become independent entities suitable for different social and programme scenarios. Polyvalence and ambiguity in use require standardization and implementation of a unified model of space structuring and organization. Differences of spatial requirements are overcome by superimposing functions in the plan or by meaningful division of typical units.

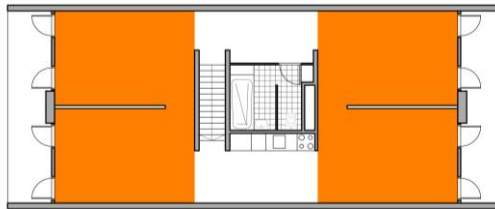


Fig. 4 The principle of neutrality and polyvalence with indication of universal rooms

3.4. Principle of openness

An open plan designed with a certain degree of incompleteness and contents that organically permeate and are connected with each other, is one of the possible concepts of flexibility (see Fig 5). The openness of the plan is stimulated by the designer's intention to leave tenants the opportunity to independently organize the space, according to their own needs and desires. The incompleteness of the spatial system that leads to freedom of interpretation, however, requires a certain professional orientation. The potentials of space partitioning can be represented by suggesting the possible position of the walls in the interior (dashed lines). The openness of the space should have its limitations. Due to the complexity of human needs, it is desirable that, in addition to sanitary facilities, there is the possibility of physical separation of at least two more zones with alternative functions, in order to avoid conflict between them.

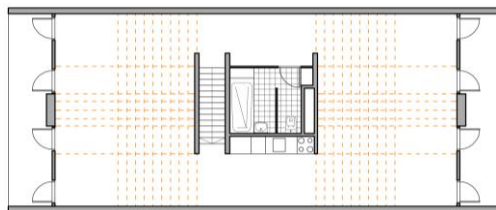


Fig. 5 The principle of openness with indication of the possible partitioning options

3.5. Principle of modularity

Openness, neutrality and polyvalence are closely related to the principle of modularity. Similar to a traditional Japanese house, in which the size of the rooms and the positioning of the pillars correspond to the tatami's module, the plan should be based on a universally adopted and standardized system of measures (see Fig. 6). Designing

within a single system of modular coordination is essential to the concept of flexibility because universality which lies at the core of thinking leads to programmatic diversity. In this manner, a balance is established between the conflicting demands for standardization in construction and programme diversity in exploitation. Unification of the structural platform ultimately results in greater freedom of “generic space”. Coordination of construction elements with the architectural design should enable variability in the organization and multifunctional use of space. In this regard, in the design phase, it is necessary to anticipate possible spatial and functional scenarios and dimensional frameworks of potential housing functions in the appropriate design module.

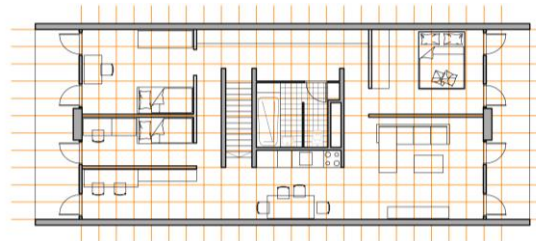


Fig. 6 The principle of modularity with the possible space division in a modular grid

3.6. Principle of division and integration

Flexibility is based on the criteria of elementary ambivalence of social life, which equally treats human's need for isolation and togetherness. The possibility of organic connection of spatial units within a meaningful functional entity of higher level, i.e. the possibility of entity's division into segments of lower level, while preserving the spatial and functional integrity of space, is one of the elementary principles of flexibility (see Fig. 7). The degree and modality of changes in fragmented-integrated relationship depends on the applied design concept. It can be based on a permanently defined or controlled pattern of use. The application of flexible equipment that enables a regulated connection between individual spatial units is a suitable solution for dynamic programme concepts, in which changes are manifested intensively, often on a daily basis. Preferences in relation to the degree of space division depend on personal affinities, structure and type of household.

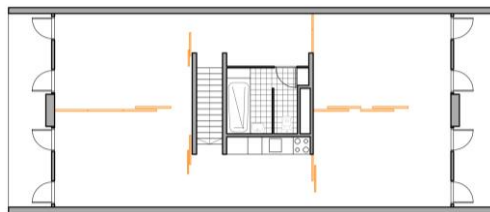


Fig. 7 The principle of division and integration with presented application pattern

3.7. Principle of spatial reserves

The floor area is a crucial criterion for conceptualization of the flexible plan. The reduced area irreversibly limits the possibilities of variable organization and room upgrading within

the unit. Defining the optimal apartment area is an essential issue that cannot be solved exclusively on the relation between the household structure and the structure of the unit (number of bedrooms). As the floor area of living space increases, structural characteristics become a minor criterion for meeting unexpected or forecasted housing needs over time. In this regard, it is desirable for space to be to some extent oversized. In this manner, the spatial reserves in the comfortable phase of exploitation will be activated and used in the most crowded phase of family development (see Fig. 8). For reasons of economic acceptability, in the case of a nuclear family household, housing standards in the initial phase of household development would correspond to the area maximum, while in the mature phase of development they would correspond to the area minimum. The adopted normative standards of the lower structure correspond to the minimum spatial standards of the higher structure.



Fig. 8 The principle of spatial reserves with possibilities of plan arrangements

4. DISCUSSION

Some of the presented principles are closely interrelated, some can be individually implemented or combined with other principles, depending on the degree of built-in flexibility. Stratification of space into layers is essential for understanding and applying the concept of flexibility. Within the system, the spatial criteria that are being the subject of physical changes and those that are permanently defined are identified. Researching the correlative relationship between determinants and elements in a free interpretation can introduce certain spatial directions on the basis of which the other principles of flexibility are further defined. The stratification of space into variable and immutable components is,

therefore, the first step in the formation of a sustainable system and a prerequisite for all other stated principles. Grouping the determinants in the plan is a desirable, but not always possible option, which depends on the broader spatial picture and technical and constructive conditions, as well as the requirements of the space functionality. Central positioning of determinants in the core, while the surrounding space remains free and allows circular communication, requires a certain spaciousness of the apartment. The conceptual design of the plan that characterizes the system of rooms without a clearly defined purpose is directly related to the principles of modularity and plan openness. The openness of the plan also requires spaciousness, multiple exits to the facades and a concept that enables optional space partitioning. Openness, neutrality and polyvalence require standardization and implementation of a modular system of measures, because the unification of the structural platform ultimately results in greater programme variability. Modularity, however, must be supported by further design decisions that allow for optional partitioning, without endangering the functional and structural relationships as well as the ambient space qualities. The concept of functionally neutral spaces, as well as the application of flexible elements in the plan that can be periodically opened or closed, are not particularly applicable solutions in architectural practice. Movable elements make construction more expensive and require special sound insulation standards. The movement of elements in the daily mode is mainly a consequence of necessity, and not a desire to reconfigure the living environment. The floor area of the apartment is a key parameter of flexibility. The larger the apartment and the surface reserves within it, the greater are the potentials of rearrangement. An oversized apartment, however, is an “economic unreality” [8]. Even in practice an undersized apartment is often preferred, with standards of subsistence minimum. The area of the apartment should be adjusted to the number of their tenants in the most crowded stage of development, while remaining within the limits that are socially and economically acceptable [9]. Considering the concept of flexibility is a complex and multi-layered problem and requires certain professional skills and design experience in anticipating future programme scenarios. The application of these principles requires adequate education of designers and raising awareness within them about the importance of flexibility for housing sustainability.

5. CONCLUSIONS

The paper systematizes and presents the basic design principles of flexibility. The principle of stratification into static and dynamic layers actually means that in the initial phase of design it is necessary to define a constitutive framework that will, at a later stage, adequately accept upgrading and variability in the system. The principle of coherent grouping implies the integration of related content according to the principle of permanence and variability in the plan, which achieves greater flexibility of space in free interpretation. The formation of neutral spaces that correspond to multiple purposes and functions is also one of the principles that leads to the prolonged exploitation of the apartment. An open plan, designed with a certain degree of incompleteness, leaves enough space to tenants to rearrange and organize the space themselves, according to their own needs and desires. Openness, neutrality and polyvalence require standardization and implementation of a modular measures, because the unification of the system ultimately results in greater program variability. The initial increase in the floor area within economically acceptable

limits enables the spatial reserves present in the comfortable phase of exploitation to be activated and used in the most crowded phase.

Implementation of flexible programmes and spreading awareness of the importance of systemic reforms in housing among professionals are desirable measures for improving the quality of the living environment. It is necessary to emphasize that the flexible potentials of the plan are the result of the correlation of numerous, interdependent spatial determinants, which by their joint action affect the quality of the offered design solutions. Anticipating programme scenarios is an important precondition for realization of the concept of flexibility because the implementation of the principles requires a multifaceted view of the spatial relationships among key architectural elements. If some of the individual conditions are not applied adequately, it can lead to the complete inapplicability of the principle of flexibility.

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O FLEKSIBILNOM STANOVANJU: OSNOVNI PROJEKTANTSKI PRINCIPI

U doba korenitih društvenih transformacija, zahtev za fleksibilnošću prostora može se identifikovati kao jedan od strateških prioriteta održanja urbane sredine. U kontekstu socijalne, ekonomske i ekološke održivosti, stanovanje mora podrazumevati integrisanu sposobnost da reaguje na programske promene, što se može ostvariti kroz koncept fleksibilnosti. Identifikacijom i primenom određenih projektantskih principa moguće je preduprediti problem funkcionalne zastarelosti i nepodobnosti stambene sredine sa kojima se suočavaju savremeni gradovi. Stan kao neposredno životno okruženje je najdirektniji indikator stepena prilagodljivosti fizičke sredine savremenim potrebama čoveka. Analizom osnovnih projektantskih principa na primeru fleksibilnog stana preispituju se prostorne korelacije i zakonitosti odnosa elemenata plana, na osnovu čega se donose zaključci o realnosti primene koncepta u praksi.

Ključne reči: *stan, stanovanje, fleksibilnost, projektantski principi, održivost*