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FUNCTIONAL AND AESTHETIC TRANSFORMATION OF INDUSTRIAL INTO HOUSING SPACES

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Abstract. *Buildings preservation by the conversion of their function has become a domain of interest in the field of industrial heritage. Due to the need to expand existing housing capacities in urban areas, a large number of industrial buildings are nowadays converted into multi-family and single-family housing. The paper deals with the analysis of the functional and aesthetic internal transformation of industrial into housing spaces. The research goal is to determine the principles of conceptualization of housing functional plan within the framework of the original physical structure of the industrial building, at the architectonic composition level and housing unit (dwelling) level. Besides, the paper aims to check the existence of common patterns of the aesthetic transformation of converted spaces, examined through three epochs of the development of industrial architecture: the second half of the XIX century, the first half of the XX century and the post-WWII period.*

Key words: *interior, conversion, industrial space, housing space, functional transformation, aesthetic transformation*

1. INTRODUCTION

In the process of forming new or adapting existing physical structures, architectural design is the basic instrument of (re)shaping a spatial environment following human needs, cultural, urban and economic requirements. The architecture of internal spaces represents an integral part of the design process, while the users' behavior and their comfort depend largely on the quality of the interior designs (Petermans & Pohlmeyer, 2014; De Botton, 2006). Internal architecture implies an appropriate choice of design elements whose mutual relation, rhythm, and position, a contrast in terms of colors, materials, textures, and lighting, form the specific aesthetic experience of the space, functionally and constructively justified. The functionality, as the primary determinant and the usable dimension of the interior

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spaces, is determined by the activities of the users. The constructive component defines volume and form of the interior space, resulting in a compositionally harmonic entity (Kojić Đ., 2001).

The contemporary concept of sustainable development has brought the field of actions in terms of urban recycling, as well as the revitalization and conversion of the buildings that are no longer in use, often recognized as a significant part of built heritage. In the process of conversion of abandoned buildings into new purposes, the interior spaces of the existing structures suffer the highest degree of transformations. Changes can be recognized by the functional and aesthetic transformation, originally already defined spatial forms, followed by an appropriate contemporary interpretation of tradition, all to create new sustainable values and solutions. Generally, there is a tendency for partial or complete preservation of the identity of the building and its cultural values, adding a layer of functionality while respecting human needs and current trends. Such spatial permeation creates new interior designs combining historical and contemporary styles (Tappe, 2017).

Due to the restructuring of the industrial sector, many production facilities have been closed, while nowadays abandoned areas and buildings occupy locations in the city centers (Stangel & Witeczek, 2015; Špirić, 2015). To preserve recognized values of industrial architecture and physical structure of the buildings, the issue of conversion of industrial buildings has become more important. Industrial buildings can be successfully converted into different types of purpose, depending on their morphological characteristics, site conditions, economic and social factors. Due to the continuous urbanization processes as well as growing demand for the construction of housing environments (Živković et al., 2016), local communities often choose to convert abandoned industrial facilities into single-family and multi-family housing.

The paper examines the conversion of the former industrial facilities into contemporary housing spaces. Research provides an overview of the functional and aesthetic transformation of the interior spaces, valorizing the determining parameters. The research goals are:

1. Determining the principles of a functional layout within the framework of existing physical structures, at the architectonic composition level and the level of the housing unit (dwelling) of a newly designed housing facility;
2. Analysis of the aesthetic transformation from the aspect of the preservation degree of the original internal form, construction, materials, and their correlations with the newly introduced design elements and equipment, as well as the determination of common principles of aesthetic transformation recognized through the epochs of the development of industrial architecture.

2. ADAPTIVE REUSE OF INDUSTRIAL INTO HOUSING SPACES

2.1. Historical development and features of industrial buildings

Industrial architecture evolved alongside the emergence of the industrial revolution in the second half of the XVIII century, triggering social and technological development around the world. The first buildings were built to set up appropriate constructive elements to protect the production process from external conditions, while visualization was neglected (Kojić B., 1962). Economics and rationality of the production process were key motives in designing industrial buildings. At the beginning of the XX century, architectural design principles started to change due to the increased need for a comfortable working

space. Nowadays, the aesthetic of form, facade articulation, used materials and construction systems, which is closely related to the historical epoch as well as their morphological characteristics, makes them authentic in the term of built heritage.

Industrial buildings from the late XVIII and XIX centuries were mostly built in the form of *mills factories* that included different manufacturing plants and warehouses in urban areas (Tyrrell, 1911). The physical characteristics of their interiors had resulted from the need to provide adequate spatial capacities for equipment and machines of large dimensions, without the existence of many internal obstacles, developing an open functional plan. These multi-story facilities were often built in a masonry system, made of brick or stone, or with timber structural frames with flat roofs, and isolated staircases for fire protection (Douglas, 2006). Constructive elements and materials were visible from the outside and in the interior of the buildings. The elongated rectangular forms enabled optimal natural transverse lighting and ventilation of the interior spaces, through the openings positioned in a uniform rhythm on the longitudinal facades (Table 1).

Industrial buildings from the beginning of the XX century were made of concrete and steel, in a frame construction system. The use of these materials soon enabled the construction of significantly bigger structures, housing all stages of the production process in one building. Industrial zones moved from urban to peripheral areas of the cities. Firstly, facilities were built in the form of multi-story daylight factories, with a visible construction and large openings that spread from floor to ceiling, providing a high degree of penetration of natural light into the interior (Cantell, 2005). In the following years, steel took the lead in the construction of single-story large-span industrial buildings (Table 1). High flexibility characterized their interior spaces, while the lighting was enabled also through roof lanterns (Jevremović et al., 2012). In the first half of the XX century, industrial architecture also developed under the influence of Modern movement (Le Courbisier, 1973).

Table 1 Overview of the characteristics of industrial buildings by epochs

Historical epoch	2nd half of XIX century	1st half of XX century	post-WWII period
Location	urban areas	urban/peripheral areas	peripheral areas
Number of floors	mostly multi-story	multi-story/single-story	mostly single-story
Building composition	elongated, rectangular	elongated, compact	various
Form of the roof	flat/slope	flat/slope	flat/slope/jagged
Openings character	uniform rhythm, often arched upper part	uniform rhythm, square and rectangular shape	various rhythm and forms
Openings dimension	medium	"from pillar to pillar"	various
Construction system	masonry/frame	frame	frame
Construction span	medium	large	various
Structural elements	brick/stone walls	concrete/steel pillars	concrete/steel pillars
Material - walls	brick/stone	concrete/brick	concrete/metal panels/asbestos
Material - celling	brick/stone/timber	concrete/steel	concrete, steel

Industrialization in the post-WWII period reaches its peak with the expansion of the cities. Industrial buildings were massively constructed in the 1950s and 1960s in the peripheral areas of the cities. They were built in the form of single-story and multi-story facilities, characterized by the minimal thermal standard, and the variety of forms and structures (Douglas, 2006). The post-WWII buildings were under the strong influence of

Modernism, using prefabricated concrete for structural elements (Milojković et al., 2017). They were often in a steel frame construction with large roof surfaces and the use of materials as concrete, lightweight metal panels and asbestos for façade construction.

2.2. Protecting industrial heritage using the principles of adaptive reuse

Deindustrialization swept Western capitalist countries in the 1970s while at the end of the XX century brought the decline of manufacturing in the socialist countries, causing many urban changes. Due to the shift of the industry-based economy to the service sector many industrial complexes were closed, so nowadays these brownfield areas occupy the attractive urban cores. Abandoned industrial buildings are no longer needed for former purposes, while new production facilities are intensively built-in peripheral free zones (Stas, 2007). In some cases, facilities are being demolished to release previously occupied areas for new urban activities, while in others they are recognized as suitable for the reuse (Stanojević et al., 2019).

The idea of preserving industrial heritage was developed primarily to use the social, cultural and economic benefits of brownfield areas while promoting the identity of the city to attract domestic and foreign investment, tourists and the population (Hussein, 2017; Mengusoglu & Boyacioglu, 2013). At the end of the XX century, the adaptive reuse of abandoned facilities is recognized as the concept that supports the sustainable change of the built heritage. Adaptive reuse not only prolongs the lifespan of industrial buildings but also preserves and cultivates valuable elements of industrial architecture of different epochs (Turnšek, 2013). It involves a set of measures of transforming the existing architectural structure following the functional, technical, constructive, and aesthetic requirements set by the new purpose. Further, it requires the legally prescribed permission to change the purpose of a facility, reconfiguration of the functional plan (implementing a new functional matrix into an existing construction pattern), as well as recycling materials and components of the envelope of the building. New requirements must be met within the physical boundaries of existing facilities, resulting in transformations of space relative to the original structure (Eyuce O. & Eyuce A., 2010).

Designed to accommodate large machines and other equipment, industrial facilities provide significant opportunities in terms of conversion into different purposes. Their adaptability depends on their morphological characteristics, resulted from the typology of industrial facilities (mills factories, daylight factories, single-story halls, etc.) characterized by the different number of floors, span dimension, type of construction, used materials, etc. (Straton, 2005). The conversion process primarily reflects on internal architecture. Designed program of contents determines the extent and type of interventions within the facility. In this regard, internal architecture, design, and conversion are closely related to the different degrees of the transformation of a given space. New interventions within already-built structures require the establishment of an appropriate relationship with the existing spatial composition, whereby we distinguish three models of interventions (Keković, 2014):

- full respect for inherited spatial structure;
- creating a new spatial structure with respect to the existing one;
- built-in the new structure into the existing space.

The choice of an intervention model in the conversion process depends primarily on whether the building is under a certain regime of built heritage protection, or whether there are legal constraints in terms of the level and scope of interventions. In case of

cultural monuments, there is no change in the external form and envelope of the buildings, while interventions are concentrated only on the interior, using the existing structural pattern and materials, with additional contemporary materials and equipment. The approach is related to the personal affinity of the designer and his/her developed sense of preserving the industrial heritage. Redesigning the interior can be conservative, completely contrasting with the original, or a compromise between contemporary and inherited.

2.3. Possibilities and constraints in the conversion of industrial into housing spaces

Progressive urbanization processes have caused an increase in the number of inhabitants in urban areas, raising the question of the need to expand the capacity for housing within existing urban structures. Strengthening of the real estate market across the world has a huge impact on converting abandoned buildings and areas into residential purpose (Turnšek et al., 2018). Thus, the costs of constructing buildings, the price of renting apartments and land acquisition are reduced, while protecting the resources of local communities (Živković et al., 2011). Also, given the attractiveness and position of abandoned buildings within the urban areas, former industrial facilities are often converted into residential ones. In the process of transformation, it is necessary to respond to the needs of future users and to fulfill the requirements of the housing purpose, related to the dimensional characteristics of the space, views, orientation, access, natural lighting, etc. In this regard, different types of industries, depending on their morphological characteristics, are more or less adaptable and suitable for converting to multi-family or single-family housing.

Physical parameters (criteria) to be taken into account in the process of conversion into housing spaces imply (Petković-Grozdanović et al., 2016):

- the spatial capacity of the building (size, number of floors, cross width/depth);
- the possibility of natural lighting of the interior of the building;
- qualitative functional organization and flexibility of the new housing space;
- the possibility of forming open areas (terraces);
- the ability to form and/or to implement horizontal and vertical communications.

The spatial capacity of the building depends on dimensions of the existing structure, its volume and the number of floors. Multi-story industrial buildings, such as XIX-century mills factories are suitable for conversion to multi-family housing. In the process of their reuse, the dwellings are positioned on higher floors, while lower floors are intended for commercial and business contents. Single-story industrial facilities can be successfully converted into single-family dwellings. If the spatial capacity does not meet the requirements, there is a need for vertical extension or division of the existing form and volume. The cross depth of the building determines the degree of natural light penetration into the interior as well as the functional layout of the architectonic composition. The cross depth up to 16m provides high-quality natural lighting with the possibility of forming a central corridor, supporting the sub-division of the plan (Llewelyn, 2000). Mills factories have an optimum depth for conversion into multi-family housing, while single-story one-span facilities are suitable for single-family housing. Additional interventions in the form of introducing atriums are needed for other types of industrial buildings.

The quality of the layout of a newly-designed residential building depends on the degree of flexibility of the existing structure. Optimal spans, applied construction systems as well as the open functional plan, that characterize industrial buildings, make them suitable for conversion. Outdoor spaces are formed by the introduction of terraces in multi-family

housing. Roof gardens are characteristic for lofts within former multi-story industrial buildings and single-family dwelling of former production facilities. Respecting fire protection demands, if the functional plan allows, the existing staircases are used, while otherwise, it is necessary to introduce an additional staircase within or outside the existing facility structure.

3. CONCEPTUALIZATION OF THE FUNCTIONAL PLAN IN THE CONVERSION PROCESS

The conceptualization of the functional plan of the adapted industrial structures will be examined through two different levels: the architectonic composition level of the new residential building and the level of the individual housing unit (dwelling).

3.1. Architectonic composition level of converted industrial building

The architectonic composition of a residential building includes dwellings, as its building elements, vertical staircases, and elevators that connect floors, corridors to access to each housing unit, common premises, and open outdoor spaces. In the process of conversion of former industrial facilities, spatial modifications are recognized by adapting the disposition of new contents in already defined spatial forms and constructive scheme. Given that industrial facilities, both single and multi-story, are most often characterized by an open plan, with the absence of internal walls or a limited partition of different phases of the technological process, the conversion implies a certain degree of vertical and horizontal division into smaller functional units. The following functional parameters for future residential building should be considered, at the level of the architectonic composition:

- clustering the housing units concerning the position of staircases and corridors as well as the existing constructive scheme;
- the position and number of staircases and corridors on each floor;
- qualitative functional layout and flexibility of the newly-designed space;
- the access to housing units and their degree of individualization (privacy);
- the implementation of outdoor spaces.

Multi-story industrial facilities suitable for conversion into multi-family housing are of elongated rectangular forms. They have an envelope consisting of supporting masonry walls or/and frame construction with a limited number of internal pillars. In the conversion process, the existing plan is divided into smaller functional units transversally. The housing units are positioned along longitudinal facade fronts, following the existing pillars disposition in the formation of partition walls (Figure 1,2,3). Thus, the pillars are not visible within the dwelling or as "dotted" elements do not burden the functional plan. The depth of the building enables the formation of a central corridor, in relation to which the housing units rely on its both sides. Their orientation is one-sided or double-sided with those occupying the angular parts of the building (Figure 1). Ground floors are often conceived with private external entrances to each of the dwelling, contributing the degree of individualization and living quality. Staircases, usually positioned along one of the longitudinal facades, remain preserved with certain constructive reinforcements or are replaced by the newly-designed ones, retaining the same position as in the original facility. If the number of existing staircases is not sufficient, the introduction of new ones occurs in the form of annexed vertical volumes, which rely on the external side of the longitudinal facade front (Figure 2). The service facilities (sanitary

facilities, kitchens, etc.) are positioned to the inside of the plan, while the premises that need natural lighting (living room, dining room, bedrooms), to facade fronts.

In order not to reduce the existing spatial capacity at the expense of long internal corridors, and to provide the optimal area surface of the housing units, accesses can be in the form of shorter corridors along the external facades. When the cross depth of the building exceeds the optimal measure of 16m, the central atrium must be formed, between which staircases and corridors are positioned. Thus, the architectonic composition is in the form of a double-track solution (Figure 3). The access to each of the housing units is enabled via private corridors, which increases the degree of individualization. When buildings are under the regime of the heritage protection that does not allow additional interventions on the facades, the open areas of housing units cannot be designed (Figure 2). In some cases, when the former industrial building has a small number of floors, there is an extension and the formation of roof terraces for two-level or three-level dwellings (duplexes or triplexes). In multi-story buildings, if there is legally prescribed permission, consoled terraces appear as new facade elements (Figure 3). In ground-floor dwellings, open spaces are often in the form of courtyards, as in single-family housing.

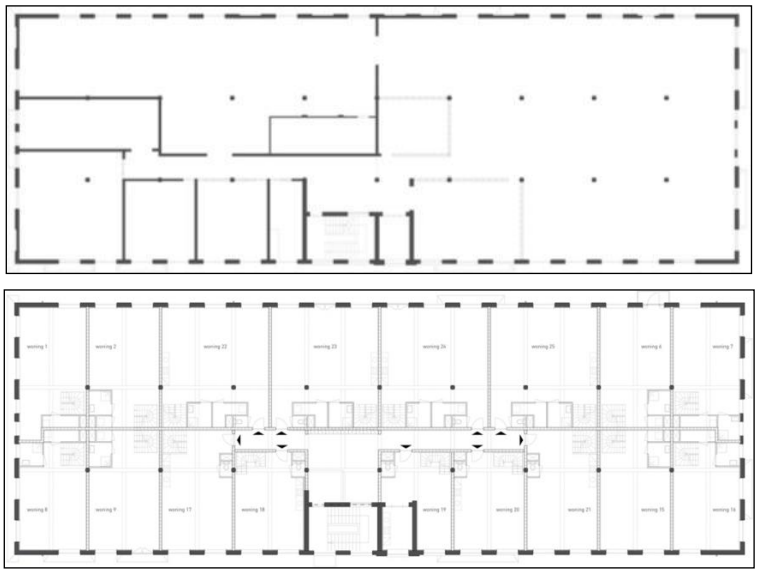

Fig. 1 Conversion into multi-family housing - De Lakfabrieken, Netherland, 1925/2018 (Source: https://www.archdaily.com/904708/de-lakfabriek-wenink-holtkamp-architecten)

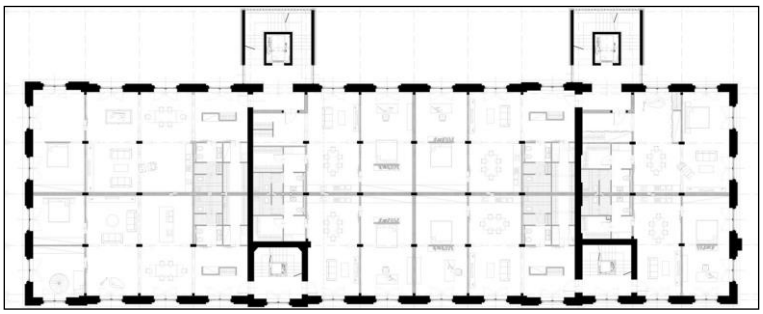

Fig. 2 Conversion into multi-family housing - Granary Gliwice, Poland, 1892/2008
(Source: https://www.archdaily.com/36172/adaptation-of-former-granary-medusagroup)

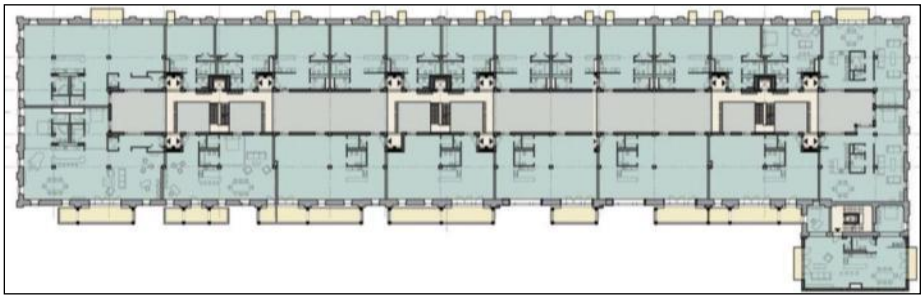

Fig. 3 Conversion into multi-family housing - Mill Lofts, Budapest, 1880/2008
(Source: http://www.capitalrealestate.hu/PDF/Mill/Malom_ENG_bel.pdf)

Single-story industrial facilities are mostly of elongated rectangular forms, built in the frame construction system. In the process of conversion into a single dwelling, the functional plan is not divided. In cases of conversion into two or more housing units division is done transversally, positioning the units along the longitudinal facades (Figure 4). In this way, each housing unit has double orientation, spreading over the entire depth of the structure, forming row dwellings. Often, a vertical division of one-volume spaces into duplexes is done, introducing celling construction or upgrading with a new volume. If there is no possibility for the formation of the courtyard, the roof terraces can be formed. The facilities with a jagged roof can be successfully converted, with the formation of roof-level penetration to create open area and additional interior lighting.

Fig. 4 Conversion into single-family housing - Plans of Prato Lofts, Prato, Italy, 1960s/2008
(Sources: https://www.archdaily.com/311426/prato-lofts-mdu-architetti)

3.2. Development of the functional plan of an individual housing unit

At the housing unit (dwelling) level, the following parameters should be taken into account, which also affects the flexibility (Živković & Jovanović, 2012):

- the layout of service facilities, daily and night zone of the dwelling;
- the position of the staircase in duplexes and triplexes;
- the orientation of the housing unit and the geometry of the functional plan;
- the implementation of open spaces.

The main motive of the layout of individual housing unit, in the process of conversion of industrial spaces, is the open plan, achieved by minimizing the interior division. The plan geometry is mostly compact, but there are cases of "L" shaped basis. The orientation of the dwelling ranges from one-sided or two-sided in multi-family housing, or more in single-family housing. In one-level dwelling, the daily zone is unique space, while the bedrooms, kitchen and sanitary facilities are isolated by walls. In case of two-level or three-level dwellings, the lower level represents a daily zone, while the upper levels, usually formed as a gallery, is a night block with a work space (Figure 5). By introducing gallery floors, the feeling of openness of the living space is created in the vertical plane. Similar principles are also applied in conversion of single-story industrial facilities. In some cases, bedrooms are separated by moving, light fixed walls or curtains (Figure 6). Open spaces are often in the form of roof terraces, while in multi-family housing there are balconies from the living rooms.

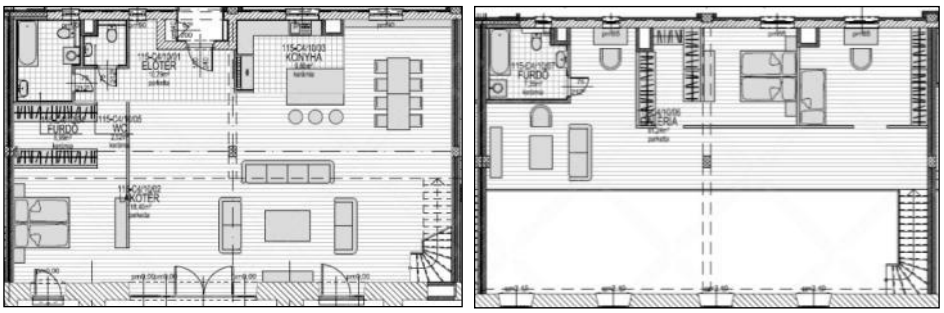

Fig. 5 Two-levels unit Mill Lofts, Budapest (Sources: http://www.capitalrealestate.hu/PDF/Mill/Malom_ENG_bel.pdf)

Fig. 6 One-family house - 102 Mill, Sidney, Australia, 1950s/2018. (Source: https://www.archdaily.com/902100/102-the-mill-carter-williamson)

4. Analysis of Aesthetic Transformation in the Conversion Process

Analysis of the aesthetic transformation of industrial spaces in the process of their conversion into housing, will be considered through parameters such as the degree of preservation of the original form, construction supporting elements, materials, and their relation to newly - introduced design elements. Further, the transformation of the interior space will be observed concerning three characteristic epochs of the development of industrial architecture, considering the design of converted industrial facilities from the second half of the XIX century, the first half of the XX century, and the post-WWII period.

4.1. Aesthetic of converted industrial space from the 2nd half of the XIX century

Industrial multi-story buildings from the XIX century were characterized by a masonry or frame construction system, with a brick or stone walls, while the ceilings were of brick or timber. The openings placed in a uniform rhythm, as a facade and internal aesthetic elements, were arched from the above, with horizontal and vertical divisions. When construction combined the outer masonry walls with the inner pillars, the pillars and ceiling were of the timber structure. A large number of industrial buildings from this period is under protection regime, as a recognized part of cultural heritage. To preserve the proportion of the interior, characterized by a distinct floor height, the practice shows that in the conversion, the same floor division is maintained. In some parts of the living space, a suspended ceiling is often used to create new internal volumes (Figure 7, right). The most common applied pattern is the introduction of a gallery floor, which makes spatial capacity more functional while the sense of spaciousness is not endangered (Figure 8). From the aspect of construction, it is necessary to make certain reinforcements of the external walls by introducing new pillars as support, as well as reinforcing the ceilings. Floor coverings are made of contemporary materials, such as decking and parquet.

Fig. 7 Interior of Time Warehouse, Santana, Japan, 1896. and Yarn Works, Fitchburg, USA, 1900s (Sources: https://www.archdaily.com/877669/warehouse-of-time-ft-architects; https://www.archdaily.com/881830/yarn-works-the-architectural-team)

The common characteristic of conversion of industrial spaces from this period is the aspiration for the highest degree of preservation of the internal form, the existing construction elements, the openings of the outer envelope and its materialization. Timber ceilings and pillars are retained as original, giving a rustic note to space. White-colored parts of walls, ceilings, pillars, and gallery floors are recognized as aesthetic elements which contrast to traditional materials and textures (Figure 7 right, Figure 8). The brick

walls are retained and combined with the timber, which gives a warm note to the living spaces. Newly introduced staircases are sometimes interesting interior elements that visually fit in the existing composition. They can appear as steel dark-colored structures, opposite to traditional materials (Figure 7, left). In some cases, the original interior is completely preserved, with interventions limited to equipping the space with the appropriate furniture. The emphasis is on the natural lighting of the interior, with the appearance of spot artificial lighting, implemented in the ceiling beams. The furniture is contemporary, often with timber elements, glossy surfaces, while new textures and strong coloring appear as individual pieces of furniture and details (Figure 8).

Fig. 8 Interior of Mill Lofts, Budapest, Hungary and Tribeca Loft, NY, USA, both from 1880. (Source: http://www.capitalrealestate.hu/PDF/Mill/Malom_ENG_bel.pdf; https://www.archdaily.com/611915/tribeca-loft-andrew-franz-architect)

4.2. Aesthetic of converted industrial space from the 1st half of the XX century

Multi-story industrial buildings from the first half of the XX century, suitable conversion to multi-family residential buildings and lofts, were built in frame construction system, most often of concrete pillars and ceilings. These buildings are specific for their openings of regular rectangular shapes, large surfaces, which were often spread all over the floor height and which had an orthogonal horizontal and vertical division.

The conversion of this type of industrial spaces into housing spaces shows certain common principles of aesthetic transformation. Existing construction elements and openings are completely retained. The pillars, beams, and walls are often white-colored (Figure 9). Sometimes, they retain original form, color, and texture, revealing the roughness of the concrete structure while emphasizing exposed installation pipes, the beams, pillars of square or circular cross-section, often integrated with" mushroom" ceilings (Figure 10). Different types of contemporary epoxy coating in neutral tones are used as final flooring. The primary characteristic of the transformed interior design lies in the minimalism present through the absence of color and details, the use of gray and white colors of walls, ceilings, floors, and stairs, as well as simple pieces of furniture. The accent is on large openings, their simple shape, and natural lighting. Artificial lighting arises in the form of inconspicuous lamps. Uniquely designed interiors of the open functional plan have a certain amount of elegance. In some cases, the user's equipment is fully integrated into the existing ambient and spatial composition in terms of neutral tones (Figure 9 on the right), while in others the accent is only on the furniture (Figure 9 on the left). The visual contrast of the monochrome scheme is achieved through specific details in bright colors, characterized by modern pieces of furniture or warm tones of certain timber elements (Figure 10).

Fig. 9 Interior of Collectors Loft, USA, 1920s and Clerkenwell, London, 1930s (Source: https://www.archdaily.com/127802/collector%25e2%2580%2599s-loft-poteet-architects; https://www.archdaily.com/794048/clerkenwell-residence-apalondon)

Fig. 10 Interior of Arts District Loft, LA, USA, 1924. and Art Loft Chai, China, 1920s (Source:https://www.archdaily.com/878049/arts-district-loft-marmol-radziner; https://hypebeast.com/2015/9/art-loft-chai-wan-by-mass-operations)

4.3. Aesthetic of converted industrial space from the post-WWII period

Industrial facilities built in the post-WWII period, occurring in the form of multi and single-story production halls and warehouses. They are characterized by a variety of forms and structures and built in a frame construction system made of concrete or steel. Openings are of different shapes and sizes. The facilities suitable for converting into housing are the small-span single-floor facilities that are simply transformed into single-family housing.

Due to the high degree of diversity of the original industrial structures from this period, the common principles of aesthetic internal transformation are not fully recognized. One of the main characteristics of the conversion process is retaining the existing construction elements. If there is no upgrading of new floors, roof construction, most often steel, remains visually attractive element in the interior. Interior transformation is usually done by adding a variety of volumes and radically changing the outer envelope in term of materialization and breaking of new openings (Figure 11). When there is a vertical space division by the introduction of the gallery floor, the staircase becomes a significant aesthetic element. Newly introduced volumes mostly comprise service facilities (kitchens, sanitary facilities, etc.) and the contents of the gallery floor. Floor coverings are of modern materials-parquet, epoxy coatings. White and

bright colors dominate the interior of the living space and appear on the walls and ceilings, but also through the users' equipment. Apart from the construction, in designing the interior nothing indicates an industrial past. Equal attention is paid both to natural and artificial lighting, to maximize the opening of facade fronts and lightning daily zones. Wood is recognized as applied material, both in the floor covering and stairs, as well as through furniture (Figure 11). Coloring is usually reduced to a few warm tones, while the application of textures is limited by balancing the texture of wood and glossy surfaces of floors and kitchen elements.

Fig. 11 Interior of Bowstring Truss, USA and Up-cycled Warehouse, Australia, both from 1960s (Source: http://www.worksarchitecture.net/work/bowstring-truss-house; https://www.archdaily.com/879131/up-cycled-warehouse-zen-architects)

5. CONCLUSION

Adaptive reuse, as a concept developed with the promotion of the sustainable principles, offers a wide range of possibilities in the field of architectural design, to extend the life of buildings that are no longer in use but are part of architectural heritage. Supporting the idea that the past should be preserved and following the requirements imposed by contemporary spatial standards, many industrial facilities have been converted into various purposes, including housing as an important urban function. The paper has analyzed the principles of aesthetic and functional interior transformation in the process of converting industrial spaces into single-family and multi-family housing. The conducted research corresponds to the issues within the initial set of research aims.

Within the framework of the goal to determine the principles of the functional layout of converted industrial buildings at the architectonic composition level and the level of the housing unit (dwelling), the carried-out analysis resulted in the following conclusions:

- practically every type of industrial facility, with appropriate interventions, can be successfully converted into housing spaces;
- the depth of the industrial building is one of the most important physical parameters in the conversion process, as it affects whether the future residential building will be conceived as a single-tract or two-track design solution in case of multi-story facilities, or as single or dwellings in a row in case of single-story facilities;
- the division of the plan must be done within the existing constructive scheme, whereby staircases remain at the same positions with the introduction of new ones if needed;

- open areas, depending on the number of floors of the existing industrial facility, its morphological characteristics and the degree of protection regime, are formed as console terraces, roof gardens, or are not foreseen by the design project of conversion;
- service facilities are positioned to the inside of the functional plan, while the other rooms of the daily and night zone of the dwelling are oriented towards the facade fronts;
- the flexibility of the housing unit is achieved through an open plan, minimizing the internal walls and/or introducing gallery floors.

Within the framework of the research goal to determine the principles of aesthetic transformation observed through the characteristic epochs of the industrial architecture, several conclusions were reached. Analyzing the design of converted industrial spaces from the second half of the XIX century the following is recognized:

- the high degree of preservation of the original form, materials and construction elements;
- the introduction of gallery floors due to large story height;
- diversity in the use of modern colors, materials, and equipment;
- the contrast between the old and the new, respecting the industrial past, while promoting contemporary styles.

Analyzing the design of converted industrial spaces from the first half of the XX century the following is recognized:

- the high degree of preservation of the original form, materials and construction elements;
- minimalism as a style present by neutral tones and simple furniture;
- contrast is emphasized using modern furniture.

Analyzing the design of converted industrial spaces from the post-WWII period the following is recognized:

- the low degree of preservation of the original form and materials;
- preservation of construction elements as parts of the industrial past;
- promotion of different contemporary styles, materials, and colors.

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FUNKCIONALNO I ESTETSKO PREOBLIKOVANJE INDUSTRIJSKIH U STAMBENE PROSTORE

Očuvanje objekata kroz njihovu adaptaciju novoj funkciji postalo je domen interesovanja u oblasti industrijskog nasleđa. Zbog postojanja potrebe za proširenjem stambenih kapaciteta u urbanim područjima, sve veći broj industrijskih zgrada se danas konvertuje u objekte za višeporodično i jednoporodično stanovanje. Rad se bavi analizom funkcionalnog i estetskog preoblikovanja industrijskih u stambene prostore. Istraživanje se zasniva na cilju utvrđivanja principa konfiguracije funkcionalnog plana u okvirima izvorne fizičke strukture objekta na nivou arhitektonskog sklopa i pojedinačne stambene jedinice, kao i ispitivanju postojanja zajedničkih obrazaca estetske transformacije konvertovanih prostora, sagledanih kroz tri karakteristične epohe razvoja industrijske arhitekture: period druge polovine XIX veka, period prve polovine XX veka i posleratni period.

Ključne reči: *unutrašnja arhitektura, konverzija, industrijski prostor, stambeni prostor, funkcionalna transformacija, estetska transformacija*