Testing the methods of reconstruction of the spatial solution of the pedestrian street

Maria Grishina

1Kazan State University of Architecture and Engineering, Kazan, Russia
E-mail: grishinih@yandex.ru

Abstract. This article describes techniques for designing a pedestrian city street in an existing building. At the beginning of this article, methods are described that determine the level of elaboration of the modernization of a city street into a pedestrian. Also publications on research into the problems of modern urban spaces are mentioned. Then the results of the analysis and the concept of the design solution are presented in the article. At the end, the assessment of the developed design solution is given. In conclusion, the results of adapting existing methods for designing urban improvement for modern engineering technologies are presented. As a result of the development of a design solution, wastelands were excluded from urban space and the promising urban development value of the territory as a whole was increased.

Key words: urban space, scenario design, pedestrian street, modern techniques, underground parking.

1 Introduction

The problem of effective architectural and functional organization of urban public spaces is quite relevant today. A feature of this problem in post-soviet cities is the already established street-road network of the industrial period of domestic urban planning. Thus, the problems of developing the underground space of modern cities are studied in sufficient detail in publications [1]. The problems of planning post-soviet cities have been studied for a long time. For example, a review of the literature on the urban environment of the post-Soviet city of Krasnoyarsk was carried out by Smolin M.G. and Koptseva N. two years ago. In the same year, Reznikova K.V. published a review of studies of the urban environment of Russian cities. There are relevant publications on the methods of planning the organization of European cities by such authors as Chistobaeva A.I. and Fedulova S.I.

The study of changes in urban planning in Krasnoyarsk at the end of the last century by such authors as V. Lusan., Pimenova N.N., Khrebtova M.Ya., Khudonogova E.A., Sertakova K.I., Shimanskaya is of interest. Some supporting methods have been restored based on the research of the architectural reconstruction of a quarter in German Mannheim by authors Petrichenko M., Rakova X., Vyatkina M., Musorina T., Kuznetsova D. [2; 3; 4; 5] in the global architecture and urban planning, the need for modern universal techniques for reconstructing the spatial solution of a pedestrian street is also confirmed by a large number of other authors. [6; 7] As the working material in the design, the working methods described in:

- an album of typical solutions for the comprehensive improvement of the embankments of the Moscow river, Moscow 2016;
- recommendations on the use of paving in the construction of coatings for residential and public-business buildings, 32-18-2016 St. Petersburg;
2 Materials and methods

The purpose of the study is to verify the effectiveness of modern techniques and design tools on the example of a street reconstruction project.

Research Objectives:
- analyze the existing functional and spatial organization of the new pedestrian street;
- script the existing use of urban space;
- make a model of the existing planning organization of the city street;
- identify conflict areas in the territory;
- determine the condition of equipment and landscaping;
- on the basis of theoretical design techniques and modern tools available to the designer to develop fundamental solutions to conflict areas;
- create a possible scenario for the use of urban space;
- make a model of the planning organization of the street;
- determine the effectiveness of the proposed design solutions.

During the study, various working methods of analysis, reconnaissance survey, office processing of the collected field data, and correlation analysis were used. In the design, scenario and variational approaches to the organization of the material urban environment were used. The work is focused on adapting the existing design methodology to modern technical capabilities and urban space planning tools [8; 9].

At the first stages of the work, data collection and systematization techniques were used. The field survey was carried out by the method of conversion and inventory of plants on the project site. The collection of initial data on the territory was carried out using modern interactive resources (electronic cadastral map, map of urban planning regulations and others). All materials collected for analysis were uploaded to electronic resources in graphical, textual and numerical formats.

During the analysis of the existing state, the territory was conditionally divided into seven fragments. Paving defects, damaged trees and shrubs, and dilapidated equipment were discovered on all fragments of the territory. Among the paving defects, the following were distinguished: inhomogeneous surface of the coating, chips and cracks on the paving slabs, lack of tile fragments, dips in the surface of the coating, incorrect vertical layout of the surface. Of plant damage, particular attention was paid to places with roots that came to the surface. The benches, swings, fences, reinforcement sticking out of the ground, and construction waste after demolition of the building were revealed from the emergency equipment [4; 10].

Analysing scheme of the planning elements conditions.

The diagram reflects the state of the road surface, types of paving, and the condition of equipment: lamps and navigation objects, urns, benches and other outdoor furniture, bicycle parking lots, shopping pavilions and equipment for children and sports grounds.

Criteria for assessing the condition of equipment:
- Excellent – used constantly, as intended;
- Good – often used for its intended purpose;
- Satisfactory – it functions, but needs repair, is rarely used or for other purposes;
- Not satisfactory – not functioning, not used for its intended purpose;
- Emergency – does not function, is broken, or is dangerous when used.

In total, 308 objects were analyzed on the territory. Of these, 4 objects were identified in disrepair, 9 objects in unsatisfactory condition, 1 in satisfactory, 25 in good condition and 269 in excellent
condition. The analysis of the public services and amenities has been found in a good order. But there is emergency equipment that is unacceptable in public urban spaces.

Based on the analysis of the pavement, existing characteristics are used that will help in a reasonable solution of the road-path network in the project area. Namely, it will allow improving qualitatively the material component of urban space.

| №  | Evaluation criterion            | Description of criteria                                                                 |
|----|--------------------------------|----------------------------------------------------------------------------------------|
| 1  | Load bearing capacity          | The bearing capacity of paving stones/paving slabs is independent of the ambient temperature |
| 2  | Device complexity              | There is the possibility of mechanized laying of stones/slabs in the coating. Stacker productivity up to 800 m² per shift. |
| 3  | Repair possibility             | Paving stones are reused. The coating is disassembled and restored back when laying and repairing underground utilities. During repair, special machines are not required. |
| 4  | Environmental friendliness of materials | Concrete, natural stone materials do not emit harmful substances into the atmosphere. It is possible to produce stones/paving slabs with a photocatalytic surface to clean the air of harmful substances. |
| 5  | Appearance                     | The use of slabs and paving stones of various colors, shapes and various processing of the front surface allows visual zoning of the space, to form a specific visual image of the urban space. |
| 6  | Water permeability             | Coatings may be permeable or waterproof. Special permeable (draining) coatings reduce the load on the storm system. |

Design solution. Techniques for creating an architectural and planning solution. A universal walking script for street Kayuma Nasyri is based on the work of the Tatar scientist-writer, after which the street is named. The motive of the ball from the fairy tale "stepdaughter" is taken as the main idea. So getting on the street Kayuma Nasyri from the street Tatarstan, tourists and citizens follow the thread of the ball, the role of which is played by the colored strip of paving, like the heroine of a fairy tale. From the street Safyan script works in the opposite direction, offering to trace the path of the tangle, which symbolizes the fountain organizing the entrance group.

Each intersection (the intersection of Kayuma Nasyri Street with Zaini Sultan Street and Fatykh Karim Street) is a public garden. In addition to solving the problem of lack of landscaping, such nodes also perform a number of other functions: a landmark, dispersal of pedestrian flows, creating a mental pause in the visitor’s imagination for the convenience of remembering and forming the image of the street. The open space interrupting the linear street also makes you look at the historical buildings and take a walk along it, which contributes to the goal of attracting and increasing the length of stay in the territory of visitors.

Change profile street Kayuma Nasyri from car to pedestrian, entails a complete replacement of existing paving. Coatings used in the pedestrian zone should ensure the comfort of pedestrians, including people with limited mobility, within the territory.

Arrangement of coatings, principle units and interfaces of pedestrian zone coating elements is carried out in accordance with the following requirements:

- created pedestrian sidewalks must ensure the continuity of links of pedestrian and transport routes, as well as free access to objects of mass attraction;
- pedestrian sidewalks should be laid along the shortest (most convenient) and safe routes of movement;
- if possible, walkways should be carried out without changing the level of the longitudinal profile;
- the arrangement of pedestrian sidewalks should be carried out taking into account the need for partial or complete separation of the main oncoming and intersecting flows of pedestrians in areas of mass foot traffic.

Two new types of paving have been added: paving stones aesthetically completing the appearance of historical buildings and paving slabs along the street axis, with a guide strip that differs from the first type with a flat surface, for a more comfortable movement. The strip serves as a guide when passing the street through squares at intersections and is a symbol from the tales of Kayum Nasyri. Objectives of the paving slab selection for the pavement are described in chapter 2.1. The analysis of the state of planning elements is given in the table "Information on the main characteristics of paving stones / paving slabs".

Landscaping stripes and an asphalt bicycle path are also added to the street profile. 2650 m² of coverage along the street Safyan and in the courtyards.

New wooden equipment fits well thanks to the selected material. Separate elements (awnings, bicycle parking) with their plastic help to support the idea of a “tangle of fairy tales” (figure 1). The luminaire in the territory of the contact zoo and information stands are subject to replacement.

**Figure 1.** Scheme of conceptual solution of design problems.

The figure shows the identified key conflict points in the territory and their solution in the developed project. On the diagram there is the honor of driveways, which became dead ends at the entrance to the pedestrian street. Also on the diagram the routes are marked according to the developed unified universal scenario for the use of this urban space. The models in the upper and lower parts reflect changes in urban space, taking into account the methods of spatial reconstruction of the city street.

The territory’s landscaping scheme has been developed on the basis of its new planning organization and the results of the analysis of the state of settled forests. The results of the inventory of green spaces and an assessment of their condition made it possible to determine the decorative and
sanitary-hygienic assessment of their content on the project site. Thus, it was revealed that over 433 trees and 49 shrubs will grow on the territory. The assortment of plantations is represented by 33 species of plants 18 of which are trees. The main species involved in the landscaping were Acer negundo (112 units) Tiliu cordata (159 units). Among the bushes there are Svida alba, Caragana arborescens, Dasiphora fruticosa.

On average, the sanitary condition of trees and shrubs in the project area was estimated at 3.6 points (max 5 points). More than half of the plants suffer from a lack of insolation, diseases, old age, mechanical damage and violations of urban landscaping care technology. Trees in emergency condition were found on the territory.

Criteria for assessing the condition of trees on a 5-point scale:

- Excellent – a young, well-formed, healthy plant. Decorativeness is expressed in the most suitable place for placing the plant. In the overall volumetric and spatial composition of the landscape of urban space and the absence of factors that can negatively affect the growth of the plant.
- Good – a healthy plant at risk of damage and disease, or planted under conditions not favorable for growth. Elimination of mechanical damage. Decorativeness is not expressed and can form any green volume. To increase the decorativeness a crown cutting is available.
- Satisfactory – the plant may be old age or be ill with treatable phytocenotic diseases. Usually requires careful treatment and care. Decorativeness is not expressed. Planting is usually required, which replaces the damaged plant without violating the spatial composition of the landscape.
- Not satisfactory – an accidental plant capable of falling. Dead wood. Such a plant requires removal with the replacement of young long-lived plants.

In landscaping, the project proposes to exclude Acer negundo from the assortment. And also, increase the participation of more valuable and durable species of trees and shrubs. The main priority is placed on the formation of a city space free from the dense shadow. This is due to the hanging of a sense of security and the preservation of visual connections under the canopy of trees for the townspeople [12; 13].

3 Results and discussion

The following results are obtained. The qualitative characteristic of the territory is developed in the form of a table and shows the need for the following transformations and systematic work to repair and update the elements of external improvement of the city street. 10 key issues are highlighted. For each of the identified problems, solutions of different scales and levels of action are formulated. The data are shown in table 2 and figure 2.

The map shows that the proposed solutions for the reconstruction of urban space are able to qualitatively change its visual image. Also, the balance of areas by functional zoning shows that urban development efficiency of the use of the territory can be increased 4 times. Thus:
- Built-up area has not changed;
- Area of passage reduced by 13,435 square meters.
- Area of underground parking lots increased by 12850 square meters:
- Area of wild car parks excluded;
- Area of wastelands excluded;
- Area for pedestrians increased by 26,690 square meters;
- Landscaping increased by 17160 square meters.

In the design solution, the balance of areas is made up of a reasonable organized urban space. The new urban space of the pedestrian street consists of 3 parts united by a single use scenario with an infinite number of possible routes for moving citizens between public objects (figure 3).

Obviously, after the modification of the street cross profile from main to pedestrian one, the freed up space will be available for pedestrians and landscaping. Thus, without changing the development on the surface of the earth and intelligently creating travel routes from building to building, it became possible to form and develop “green corridors” for comfortable movements of citizens.
Table 2. Qualitative characteristics of the territory.

| №   | The problem of low efficiency of using the space of the city | Possible solution to this problem                                                                 |
|-----|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 1   | Spontaneous parking                                        | Construction of municipal underground parking (with the function of hourly rental space for a car)   |
| 2   | Street Kayuma Nasyri has a cross-sectional construction of the main street of regional significance [SP] | Street reconstruction in the boulevard                                                            |
| 3   | Hazardous equipment and green spaces                        | Compliance with the program of municipal measures for the maintenance and operation of elements of external improvement |
| 4   | The presence of unused fragments of the territory           |                                                                                                      |
| 5   | Entrances to the spatial design area are not formed         |                                                                                                      |
| 6   | There is no expediency of the installed equipment in some parts of the territory |                                                                                                      |
| 7   | Street space attractiveness is low                          |                                                                                                      |
| 8   | High dispersion of the territory                            |                                                                                                      |
| 9   | The lack of artistic design in the spatial organization of the territory |                                                                                                      |
| 10  | There is no expediency of the installed equipment in some parts of the territory | The solution of all the elements of the external improvement of urban space in the single style of Kayum Nasyri's fairy tales |

Figure 2. Maps of the qualitative transformation of the territory.
In further studies, the author intends to use in more detail the results of studies on the behavior in resolving pedestrian gaps [13]. This will make it possible to effectively use the accumulated global experience in the transformation of pedestrian spaces. The effective use by citizens of the space of a pedestrian street is unthinkable without an understanding of social psychology. To this end, it is planned to use the results of a set of social studies: “A model for the logical adoption of passes in the pedestrian zone” [14], Cultural values and accessible respiratory tests as moderators [15], are pedestrian children intentionally at risk when in a hurry? [16], on the way to explaining age-related difficulties when crossing a two-way street [17], awareness situation of misconception and misunderstanding [18], emotions and decision making [19], fast makes risky: lack of time increases the risk of finding solutions based on experience [20].

According to the author, the results of these and new modern studies will help to more objectively assess the possibility of forming new methods of urban planning in Russia based on existing Soviet experience. In addition, an analysis of the global experience of urban planning proves the need for an urgent update of the principles, methods and techniques of professional work.

4 Conclusions
As a result of the study, the used design techniques allowed us to solve key tasks.

1. As a result of a comparative analysis of the existing and planned spatial organization of the territory, it turned out that a change in the design of the street profile will increase the urban development efficiency of the territory.

2. The proposed changes in the layout of the territory on the basis of the new formative scenario “pedestrian street” will make it possible to create a single urban space from dispersed random fragments based on modern social and cultural use cases.

3. A comparative analysis of the models for the planned design of the urban street configuration made it possible to understand the sequence and scale of the necessary changes in the city space.

4. The localization of the conflict areas made it possible to determine local measures for redecorating the elements that make up the visual and material environment of the territory.

5. The information received on the condition of equipment and landscaping in the territory is the data of ongoing monitoring of the state of external improvement of the territory.

References
[1] Kartosia B A 2015 Development of the underground space of large cities New trends GIAB S1, pp 1269-1275.
[2] Smolina M, Koptseva N, Sertakova E 2018 Literature review on the urban environment of Krasnoyarsk Journal of Siberian Federal University. Humanitarian sciences 10, pp 1653-1671. doi: 10.17516/1997-1370-0326
[3] Reznikova K 2018 Russian urban environment research review Journal of SFU. Humanitarian sciences 9, pp 1467-1485. doi: 10.17516/1997-1370-0316
8

[4] Chistobaev Anatoly I, Fedulova Svetlana I 2018 Spatial planning in the European Union: practices to draw on in Russia Baltic Region 2. https://cyberleninka.ru/article/n/spatial-planning-in-the-european-union-practices-to-draw-on-in-russia last accessed 2020/16/03. doi: 10.5922/2079-8555-2018-2-6

[5] Vladimir S, Natalia N, Mikhail Y, Anastasia E, Khudonogova E, Sertakova K 2019 Transformation of the Krasnoyarsk Urban Space in the 90th of the 20th Century Journal of Siberian Federal University. Humanitarian sciences. doi: 10.17516/1997-1370-0438

[6] Pratama A 2018 Smart city narrative in Indonesia: comparing policy documents in four cities Issues of state and municipal government 6, pp 23-28. doi: 10.17323/1999-5431-2018-0-6-65-83

[7] Chistobaev Anatoly I, Fedulova Svetlana I 2018 Spatial planning in the European Union: practices to draw on in Russia Baltic Region. https://cyberleninka.ru/article/n/spatial-planning-in-the-european-union-practices-to-draw-on-in-russia last accessed 2020/16/03. doi: 10.5922/2079-8555-2018-2-6

[8] 2017 Cool landscapes Topos magazine https://www.toposmagazine.com/cool-landscapes/ last accessed 2020/16/03.

[9] Thomas H 2017 Seeing the bigger picture: atlas of world landscape architecture Topos magazine https://www.toposmagazine.com/cool-landscapes. last accessed 2020/16/03.

[10] Anja Koller 2017 Out there landscape architecture on global terrain Topos magazine https://www.toposmagazine.com/cool-landscapes/ last accessed 2020/16/03.

[11] Petrichenko M, Rakova X, Vyatkin M, Musorina T, Kuznetsova D 2015 Architectural renovation of quarter in mannheim, germany Applied Mechanics and Materials 725-726 pp 1101-1106. doi: 10.4028/www.scientific.net/AMM.725-726.1101

[12] Zakirova J, Khusnutdinova S 2018 The problems of formation and conservation of the green frame (green carcass) of the satellite city (on the example of zelenodolsk) Kazan State University of Architecture and Engineering, Kazan Federal University, Kazan RF. doi: 10.1088/1755-1315/107/1/012139

[13] Arman M, Rafe A, Kretz T 2015 Pedestrian Gap Acceptance Behavior, A Case Study: Tehran Retrieved from Transportation Research Board, 15 p 2217.

[14] Boroujerdian A M, Nemati M 2016 Pedestrian gap acceptance logit model in unsignalized crosswalks conflict zone International Journal of Transportation Engineering, 4 (2), pp 87-96.

[15] Cestac J, Kraiem S, Assaïlla J-P 2016 Cultural values and random breath tests as moderators of the social influence on drunk driving in 15 countries Journal of Safety Research, vol. 56, pp 89-96. https://doi.org/10.1016/j.jsr.2015.12.001.

[16] Dommes A, Granie M A, Cloutier M S, Coquelle C & Huguenin-Richard F 2016 Red light violations by adult pedestrians and other safety-related behaviors at signalized crosswalks Accident Analysis & Prevention, 80, pp 67-75. doi: 10.1016/j.aap.2015.04.002

[17] Dommes A, Lay T Le, Vienne F, Dang N, Beaudoin A P, Do M C 2015 Towards an explanation of age-related difficulties in crossing a two-waystreet Accident Analysis Prevention, 85, pp 229-238. https://doi.org/10.1016/j.aap.2015.09.022.

[18] Endsley M R 2015 Sitution awareness misconceptions and misunderstanding Journal of Cognitive Engineering and Decision Making, 9, pp 4-32. doi: 10.1177/1553443415572631

[19] Lerner J S, Li Y, Valdesolo P, Kassam K S 2015 Emotion and decision making Annual Review of Psychology, 66 (1), pp 799-823. https://doi.org/10.1146/annurev-psych-010213-115043.

[20] Madan C R, Spetch M L, Ludvig E A 2015 Rapid makes risky: Time pressure increases risk seeking in decisions from experience Journal of Cognitive Psychology, 27 (8), pp 921-928. https://doi.org/10.1080/20445911.2015.1055274.