Design security adaptation of communication spaces for the modern educational forms’ implementation in the educational buildings of universities

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Abstract. The architectural and design environment of educational buildings and their open areas are adapted in the operation course to the changing educational conditions, technologies and the way of the students’, as well as the expansion of educational, communication and recreational zones. The design tools used to distinguish, isolate and transform the zones to ensure the adaptation of communication spaces to the changes in the learning process and to saturate them with the additional functions are under the study. The researched design tools for localization of the additional functions’ zones in social spaces with free planning; the design means of isolation zones (zone boundary) to create the open, half-open and closed zones being able to control the degree of the zone’s isolation; the design filling of a zone (zone saturation). The criteria for the quality of the educational building extracurricular spaces environment are proposed: dynamism, which is caused by episodic events changes; transformations for compact zones; flexibility and rationality of the educational building spaces use by applying the combinatorial method. On the basis of the field surveys of the high school educational buildings and the study of Russian and foreign experience of their design the options and methods for greater involvement of educational communication spaces for learning and recreation are proposed in this study.

Introduction
The architectural and design environment of educational buildings and their open areas are adapted to the changing learning conditions, technologies and way of students’ life in the operation course [12,13,14]. Regional targeted social programs are implemented in the field of education, culture, youth policy, physical education and sports, and in the field of social protection of the population in many regions of Russia today. Particular attention is paid to the implementation of priority national projects “Education” [19]. In this case the transformation of the educational environment of the buildings occurs primarily due to the most dynamic means, namely: the filling and design subject, as well as by changing the space-planning decision of the building [1]. Modernization of the subject-spatial environment includes equipment upgrades, expansion of functional areas or organization of the new ones. Redevelopment within the existing contour of the building makes it possible to redistribute the functional areas and find the planning reserves. When the need to expand the area of the building...
prevails, the following methods are used: extensions to the building, superstructures of volumes, integration of the external environment elements (for example, overlapping courtyards and terraces) as zones of various functional purposes (winter gardens, recreation, reserves for expanding the assembly hall or auditoriums) [2, 3,7].

**Goal, tasks, methods of study**
On the basis of universities educational buildings field studies and the study of Russian and foreign experience of their design, a number of studies noted that the communication spaces often act as space-planning reserves for adapting the existing buildings, which, under certain conditions, serve to develop communicative activities and expand such functional zones as training, nutrition, library, exhibition, etc. [3,4,12].

The interpretation of the communication spaces as planning reserves and their saturation with the additional functions of learning, recreation and communication is possible if they have a reserve of space width or height, if there are no transit zones in the plan, with sufficient height to create the additional levels. The enrichment of the communication spaces functions contributes to their adjacent location with public spaces or recreational courtyards.

A factor contributing to the greater utilization of the communication spaces of universities for learning and recreation is the distribution of more compact and less fixed equipment in one place: portable computers, devices and displays are now more common, and electronic resources and catalogs are in the libraries. In particular, the universities use the applications in teaching media technologies: interactive displays and projections, media surfaces, “virtual reality” technologies – all these allow to broadcast lectures and practical exercises and remotely participate in them, arrange “virtual laboratories”, hold conferences and round tables with distantly located participants [12,13,14] and it is possible to use the spatial reserves of communication spaces to expand auditoriums or halls. The preference is given to compactness and mobility of functional areas and their inclusion in communication spaces, which is facilitated by the use of various design tools, for example: functional modules, transformable furniture and partitions [5, 7, 15, 18].

**The new forming system design**
To ensure the adaptation of communication spaces to the changes in the learning process and to saturate them with the additional functions, various design tools are used to isolate and transform zones.

In atria and large amphitheater structures (the spaces with free planning) the design tools are usually used to select zones of various functions (micro-spaces) and passages between them (communication spaces). Such large single spaces are often included in the planning both for new constructions and for the reconstruction (the building extension or integration of the external environment elements, for example, courtyards and terraces overlapping), which corresponds to the condition for creating planning flexibility.

Considering the design component of the communication space environment, the following should be taken into account: the types of activities and characteristics of zones for them (dimensions, contour (configuration in plan), the boundary character (presence of a screen), subject filling); and the layout options zones. On this basis, it is possible to determine rational planning solutions of the communication spaces able to integrate into their space the zones of additional functions.

Projects of educational buildings are often provided with the options for the area redistribution, including those with the seasonal territorial integration. With this approach, adjacent open spaces borrow the functions of interior spaces and the territory includes discretely distributed functional areas. For example, based on the project of the educational building of the cultural and educational center, the following variants of seasonal inclusion of adjacent open spaces were tested: expanding the library unit crossing a pedestrian street, creating a buffer recreational space and opening the lobby in the courtyard (Shulginova O.A. master's thesis “Formation of architecture of communication spaces in student campuses”, SUZ, 2017, under Petrova L.V. supervision) [3,4,7,12,13].
The dotted zones on the territory of a university building or complex can be educational, library or recreational, they are equipped with modules and gazebos playing the role of book shelves, library pavilions, amphitheatre and the possibility of communicating on the computer, with a vending machine of 1.0 sq. m (for a teacher and one student), from 2.0 - 2.7 sq. m (for 2-3 people), from 3.2 sq. m (for 4-6 people); - food: a zone with a vending machine of 1.0 sq. m; area for the visitors in the cafeteria or buffet - from 18 sq. m [6,7,11,15].

In general, the placement of additional functional areas in the communication space can be side, island, mezzanine or recessed. The configuration and size of the non-transit zone in the communication space - round, rectangular, extended or pictorial - determine the placement in it and the layout variants of the functional zones. The location of working places can be of several types: ordinary, one-sided or two-sided, linear or compact, zigzag.

Two alternative options for the functional area allocation is the allocation of a separate room (as in the corridor scheme most common for educational buildings) or the fragmentation of a zone by means of design in a single open space - have their own rational areas of application. The advantages of unified multifunctional spaces are planning flexibility and the possibility of communicativeness of connecting or communicating zones, which is essential for the university buildings. But, as it is shown by the studies of the office space with a free layout, common working spaces have several disadvantages: psychological discomfort due to the large number of people, inability to seclude, high noise levels, lack of natural light and a feeling of monotony when arranging a large number of tables in rows [5, 11]. These disadvantages are usually tried to be reduced with architectural and design techniques and means, including: a combination of free space and corridor system in the layout, variable placement of workplaces, additional natural lighting of the lights and atriums, shielding and landscaping zones [8,11,14- 17]. On the other hand, the allocation of new separate premises for the modernization of an existing educational building depends on the existing planning reserves and is not always possible.

The boundary of the zone and its shielding is determined by the noise mode, visual isolation and the need for privacy during various activities: a quiet, isolated zone - for the activities requiring concentration in the performance of learning tasks and reading; less isolated zone – for the communicative activities and leisure. In connection with this it is worth saying, that the zones are distinguished by isolated or translucent partitions or are isolated by screens. The screens differ in...
stationarity, material, transparency, and configuration — to the full height or at the human stature, all around the perimeter or partially covering the view [7, 9, 18] (Figures 1-2).

**Figure 1.** Fragmentation of zones in the hall using the color of the coating and stepped structures - amphitheaters. Source: https://www.home-reviews.com/kingdom-kindergarten-for-children-in-tianjin-by-sako-architects

**Figure 2.** Permanent isolation of zones for individual work - “cabinet” as a small form in free space.

**Summary**

The acceptable design tools meeting these objectives are:

- design tools for localizing zones (highlighting the “spot” of a zone with a certain size and contour) of additional functions in communication spaces with free planning: material and color of flooring and walls; furniture; gardening; sculpture; lowering or raising the level of the floor; lamps and ceiling structures (ceiling level drop, different ceiling materials);
- design means of isolating zones (zone boundary) to create open, half-open and closed zones, to be able to control the degree of the zone isolation;
- screens, curtains, transformable partitions, modular furniture, sculptural structures, half-open and closed boxes;
- design filling of a zone (saturation of a zone): furniture, storage places, etc.

The environment of the extra-curricular spaces of the school building has a quality of dynamism, which is caused by occasional changes during the events and periodic changes during the day, week,
year - study time, workload increased during the sessions, extracurricular activities in the evening and holidays. The dynamism of functional zones in communication spaces is also caused by changes in technology, as already mentioned, and their adaptation to changing learning conditions: the emergence of the new education forms or a change in the activities’ ratio - counseling, individual and group work of students, communication and recreation [12, 13, 14].

It is necessary to provide means of transformation for the compactness of zones in the design filling of extracurricular spaces in connection with these requirements to them:

- transformable furniture,
- stored furniture;
- well thought-out system for storing unused equipment and furniture: on the walls surface, in niches, inside the podium, in cavities under the floor, on mezzanine tiers or under the ceiling, in the space under the stairs, in stepped structures - amphitheaters [9, 10].

The flexibility and rationality of the educational building spaces use is achieved by using the combinatorial method, which allows to create multiple groupings from a limited set of elements (for example, a student’s workplace, a shelving, a seat, a module with landscaping), thus using space economically, ensuring various functions and their combinations.

Combinatorics, in particular, is used in extracurricular spaces when organizing informal training and recreation zones. It provides for a variety of options for grouping furniture and equipment. The blocking of workplaces for studies corresponds to one or another form of studies (independent or under the guidance of a teacher, individual or group), which can be combined in the rooms alternated with each other. At the same time, it is possible to borrow the proven experience of solving such “informal” workplaces in co-working offices.

References
[1] Minervin G B, Shinko V T, Efimov A V and others 2004 Design. Illustrated dictionary reference. (Architecture-C, Moscow).
[2] Isakova S A 2012 Architectural Planning Modernization of University Complexes: an Example of the Southern Federal University (author's abstract of dis. Cand. arch., Nizhny Novgorod).
[3] Petrova L V, Shulginova O A 2017 Results of Field Surveys of Architectural Spaces of Educational Institutions in Terms of Adaptation to New Forms of Education (Actual problems, prospects and challenges of land management education, architecture and design, Moscow, GUZ) 195-200.
[4] Petrova L V, Shulginova O A 2018 Communication Spaces (Architecture and Construction of Russia) 2 (226) 114-119.
[5] For what They Do not Like Open spaces: 6 Architectural Errors (Electronic journal archspeech. Source). Information on http:// archspeech.com/article/za-chtto-ne-lyubyat-openspepsy-6- arhitekturnyh-oshibok.
[6] Runge V F, Manusevich Yu P 2016 Ergonomics in Environmental Design (Supplemented, Architecture-C, Moscow).
[7] Petrova L V, Shulginova O A 2015 From the Ladder as a Communication Element of Educational Buildings to Step Structures Providing Innovative Teaching Methods (the Eurasian Union of Scientists (ESA)) 4 (13) 166–167.
[8] Tkachev V N 2006 Architectural Design (functional and artistic design basics)(Proc. Allowance, Architecture-C, Moscow).
[9] Puchkov M V 2011 Principles of the Organization of Educational Space (Architectural and design schools, Architect: universities’ herald) 36. Information on http://archvuz.ru/2011_4/5 (appeal date: 12/20/2017).
[10] Ilvitskaya S V, Gorbachev D I 2017 Anamorphosis in Architecture (Architecture and Construction of Russia) 3 116-117.
[11] Ilvitskaya S V, Okhlyabin S D, Danilenko I A 2015 *Glossary of Architectural and Construction Terms and Scientific Definitions in the Field of History of Architecture and Restoration of Architectural Monuments* (Textbook, GUZ, Moscow).

[12] Ilvitskaya S V, Petrova L V, Bulgakov E A 2015 *Formation of Innovative Qualities of Teaching Methods in the System of Training Architects* (Textbook, Electronic version, Certificate of registration of electronic resource number 21178, Moscow).

[13] Ilvitskaya S V, Ilvitsky D Yu, Petrova L V 2017 *Contextualism of Architectural Education in the Russian Mezhevoi School* (Architecture and Construction of Russia) 3 6-16.

[14] Ilvitskaya S V, Lobkova T 2018 *Philosophy of Unity with Nature as Basis of Energy-Efficient House Architecture* (IOP Conference Series: Materials Science and Engineering) 451.

[15] Ilvitskaya S V, Lobkov V A, Lobkova T V 2018 *Earth Ecology and the Role of Natural Materials in Green Architecture* (Land management, cadastre and land monitoring) 9 57-63

[16] Ilvitskaya S V, Lobkova T V 2018 *Philosophy of Environmental Friendliness of Architecture as Basis of Modern Design of the Dwelling* (Bulletin of BSTU named after V.G. Shukhov) 8 69–74. DOI: 10.12737/article_5b6d585bcd1b55.50847042

[17] Ilvitskaya S V, Prihodko V 2018 *Innovative Technologies in the Field of Topography, Land Management, Territorial Planning* (Construction and Architecture, XXI International Scientific Conference on Advanced in Civil Engineering "Construction - The Formation of Living Environment" (FORM 2018) Preface, June 2018 (011001-011002), Smart City) 365 022001-022070. (022030).

[18] Ilvitskaya S V, Shuvalov V 2018 *Building of Clusters of Energy-Efficient Roadside and Road Safety Written* (XXI International Scientific Conference on Advanced in Civil Engineering "Construction - The Formation of Living Environment" (FORM 2018) Preface, June 2018 (011001-011002), Smart City) 365 022001-022070 (022026).

[19] Perkova M V 2016 *Regional Settlement System* (International Journal of Pharmacy & Technology) 8 (4) 26621-26634.