INRTU campus development strategy

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Abstract. Three models of university spaces could be considered. A dispersed model is historical universities integrated into the urban building layout with academic buildings and residences scattered throughout the city. The second model, the opposite one, is an autonomous suburban campus. Core functions are compactly located on a large site: study-residence-recreation-suburban campus in natural environment. INRTU refers to the third model: this is large campus with a full range of educational and residential functions integrated into the city. The arterial street and the bridge adjoin the site. However, the problems could be observed: lack of functions organization, places and internal street network. The university is beneficially located on the river bank, but does not provide access to it. It is interfered with low value individual building and railway. The campus suggests real opportunity to form a full-fledged recreational framework of the territory – a green cross, but garages and parking lots provide an obstacle. It is necessary to form a dense internal street network to ensure the presupposed level of territory coherence, and on its basis to build and develop technology parks, cultural center for young people, a water-sports and information-library complexes in the form of detached buildings. To form the university embankment. To overcome the environment fragmentation, and establish effective connections with adjoining universities and the academic center.

1. Introduction
The first universities were founded in Europe in the Middle Ages and resembled monastery complexes. The architectural planning technique used in the formation of those universities is called cloister as noted by M. Fadeeva [1]. This is a two-story square with inner bypass gallery, which opens into the courtyard. The first university and college built on this pattern – Spanish College in Bologna, 1364. The first floor provides academic rooms and auditoriums, the second – private residences. This closed university morphotype is associated with the desire to create a closed elite community of intellectuals. Later, in England, the yard was arranging as a lawn, as in Merton College, Oxford University, 14th century. The lawn acquires status and symbolic meaning. In the 17th century, the construction of universities in America has started. Their proposed model constitutes the campus in natural environment, taken out into suburban area. Initially, the campus combines only two core functions: residential and educational. The first university of the New World, Harvard, was built 6 km from Boston in 1636. The building, adapted for autonomous existence, presumes open U-shape. The structure includes park. In further development, universities grow into the urban environment. They purchase buildings in the city which provide dispersed model. The second model supposes universities develop independent complete social cultural and research infrastructure as far as the site allows. This is called the campus itself. In any case, an important component of the campus structure is park or wide boulevard, alley. Mobility organization of campus contributes to its success [2].

In Russia, nowadays in terms of campuses development which is largely invested (the FEFU campus cost 68 billion rubles) the state seeks to combine their construction with large international projects such as the Universiade, summit, etc. Thus, in Kazan, the Kazan Federal University received a benefit in the form of the Universiade Village [3] on a significant site of 57 hectares, inside the bypass ring road. A large neighborhood has become the university and accommodation complex. The FEFU territory is suburban model of autonomous campus. The core triad of functions is present here: academic buildings – student three stars hotel complexes, park occupying half of the site [4]. In the context of Moscow development, a site of 100 hectares in the center of the future city “Moscow A101” was allocated for the campus of the Institute of Steel and Alloys in the south. A competition was conducted. The project of the architects F. Huben, P. Strukova, M. Roy won. It is based on the regular orthogonal grid located between the pond and the forest. The transverse axis follows wide boulevard to the pond. On both sides of the boulevard 10 educational buildings are allocated in the shape of square with an area of 1 ha. The coastal zone includes student center and library. The residences cloisters are disposed on the grid sides. Multi-storey residential
buildings are lined up on the rear border. [5]. The other participant in the competition is the Ostozhenka Bureau, architect A. Skokan [6]. Academic buildings are conducted with compact enfilade of yards along the longitudinal axis. The residential project references the concept of Le Corbusier for Algeria. The proposed line length along the axis is about 1 km in the sinusoidal form. The line is raised above the ground on the pylons. From the composition center to the pond the alley conducts, continues by bridge over the pond and ends on the highway with the stop of a public bus.

2. Methods

The identification of fundamental functional-spatial models (templates) is used as the study method by which the Irkutsk universities and most of the world campuses are spatially organized. Please, refer to example [7]. Three such models can be observed. Disunited University: historically formed, residences and buildings which are scattered around the city. Suburban autonomous campus with full function complex; campus inside the city or city within the city. Irkutsk Technical University belongs to the third type of campuses. The double feature of this model constitutes that, on the one hand, the university provide the opportunity to build up its own educational, residential, recreational and research infrastructure in compact and therefore profitable form. On the other hand, the university proved the ability to integrate into the urban environment, connect and cooperate with external objects. The method second point identifies deficiencies and problems which interfere with both autonomy and coherence of the university as in internal as in external environment. The third point of the method evolves campus development provisions as strategy for overcoming deficits and problems in both areas of university development: internal and external.

In approaches to the campuses formation, the core functions presence — academic — residential — recreational — research provide key provision [8]. The campus landscape design draws much attention [9]. In western universities campuses the landscape and recreational framework is necessarily formed for the pedestrian connection of campus parts [10]. In the case of campus fragmentation, for instance, when it is cut by the transit highway, pedestrian passages and aqueducts are organized [11]. The campus open frame can serve the pedestrian street [12] in combination with squares.

3. Results
3.1 Advantages and disadvantages of INRTU campus

As can be observed from the above work [2], the INRTU campus suggests development favorable conditions. There are 11 dormitories with about 4,000 residents. The academic building accommodates more than 17 thousand students. The studies blocks, assembly hall and library are united in the main building. Campus provides stadium with artificial turf [3]. The campus advantages are the following.

INRTU campus advantages. Please, refer to Fig. 1.

The campus is beneficially located between the main street with public transport (connection to the city) on the one side and the Angara river bank on the other (valuable coastal location).

The site is large and holds large university according to the classification of QS ranking, more than 17 thousand students.

The complete topological connection exists between academic buildings and accommodations. The average distance within pedestrian availability is 580 m.

Inside the campus two vacant passages remain more than half of which are landscaped. The two such passages create so-called green cross.

The green cross establishes the order and limitations of the random building process. The territory is divided into four interconnected blocks: a) educational, b) student accommodations, c) mixed, including teacher residences, d) sports unit.

The sports unit includes stadium with improved artificial turf and gym as part of the main academic building.

The possible formation of the Angara waterfront.

Problems, as is often the case, are closely related to benefits. The INRTU campus provides also 7 main problems.

The university is located 100 meters from the Angara river banks. Nevertheless, occupying an advantageous position in relation to the river it does not provide access to the river. There is no University waterfront or embankment. Two obstacles between the university and the Angara River can be allocated: low-rise housing buildings of low value with fenced land lots, and a part of Trans-Siberian Railway. In addition, the relief difference from the edge to the water surface is about 25 meters.

The lack of green recreational areas can be also observed on the campus. However, two wide vacant passages can be founded. One passage locates along the Igoshin Street and leads to the river. The other goes along the academic building, parallel to the Lermontov Street and comes to the
Kurchatov Street, which serves as the campus southeastern border. Two mutually perpendicular passages form the potential green cross. Although, firstly, the garages and parking lots presumes on this territory occupying 40% of its area. Secondly, the passage leading to the Angara is interrupted not reaching 100 meters before it.

The residential unit is outdated morally and physically, living conditions in which do not meet hygienic standards. Similar problems could have been observed in the Ural Federal University residences before the reconstruction – 6 students lived in the room, and one kitchen and one bathroom were provided on the floor [14].

The lack of technology park area. There are only 2,000 sq. meters available. In the technical universities of such size the technology park area reaches 50,000 sq. meters [15]. The lack of socio-cultural and information infrastructure. The absence of cultural center for young people. The absence of stand-alone library building. The absence of swimming pool. These are all necessary facilities for large university.

The lack of internal street network. Internal streets are represented by Igoshin Street and two passes without names. The campus large areas did not provoke the pedestrian traffic and the beginnings of streets did not create network. The link between stadium and residences in the coastal part is also in its early stage.

It tends to campus fragmentation and limited external connections with adjacent urban objects: antenna field, neighborhood on Ivan Franko Street. The initial site within the boundaries from Lomonosov Street to Kurchatov Street intended for the university development was significantly reduced due to the site withdrawal under the antenna field of 14 hectares. This site is needed for campus development. There is no connection with the sites located on the main street opposite sides (with geological technical school). The campus connection with the public center of the Sverdlovsk administrative district is also lacking.

3.2 INRTU campus development strategy

As an approach to solve the identified problems and based on the INRTU campus advantages the development strategy is proposed.
A. Establishment of university and river connection. The first problem suggests that the campus is favorably located in the coastal line, while the real connection with the coast is broken. The obstacles to connection establishment between the Angara River bank and the University embankment are the following: the railway and the individual building line along the Lesya Ukrainka Street. The residential buildings elimination as an obstacle to the contact of the university and the river is possible in several ways. The first way proposes to agree with the city general plan decision of 2008 and to lay a highway of regional significance in the alignment of Lesya Ukrainka Street. According to the Urban Planning Code [16], during the construction of linear facility, the residents are evicted from transport corridor with compensation for property damage. The connection between University and river bank can be reached in this case. The priority is recognized the importance of the university as a city-forming object, and the disclosure of representative panorama of the embankment.

Figure 1. The INRTU campus location and its components. Google Earth satellite image dated 17.08.2018.

The second way suggests the private property of one hundred and fifty citizens is recognized as the priority. The property rights on these land lots are registered according to the cadastral plan [17]. The second way key point is to reformat the building pattern. Now it is presented as individual house with fenced land lot. No building breaks can be observed, which excludes the possibility of reaching the Angara river bank. The idea is to replace the manor building with low-rise blocks. Boulevard on the axis of Igoshin Street leading to the river should reach it. It would be possible if two blocks of row houses are built on both sides of Igoshin Boulevard on the manor building site. Studies for Ulaanbaatar, Mongolia, recognize the manor building
transformation from low-value houses with lots into full-fledged townhouses neighborhoods as possible and effective [18]. At the time of this study, the land lots on Lesya Ukrainka Street No. 23 and 25 were empty and put up for sale. Their cadastral value comes from 2 to 4 million rubles. The total area of all plots constitutes 2.2 hectares. The building density reaches 70 people/ha (total lots 47). The row low-rise buildings density would reach 230 people/ha [18]. Thus, all residents (about 140 people) could be rehoused in one block of 60x100m, and the same amount of apartments would be for sale. Upon reaching the connection with the coastal line, the future Igoshin Boulevard would face the following obstacle: Trans-Siberian Railway track. It is possible to overcome this obstacle in two ways: by the pedestrian platform on top and by the reconstructions of the roadway with a tunnel descending to the embankment.

B. The green cross formation. This strategic position is related to the shortage of open public spaces. At the same time, the real possibility of recreational territories system forming in terms of logical planning can be observed. The existing open green spaces stretch along two mutually perpendicular axes. The first axis is the Igoshin Street (transverse passage). The length is 604 meters, the width varies from 33 to 78 meters, and the area is 3.4 hectares. The second axis (longitudinal passage) connects the park on the academic building back side and the sports ground adjacent to Kurchatov Street. This axis serves as the border stretched along Lermontov street campus elements – the academic building and residences blocks.

Figure 2. INRTU campus spatial development strategy. The author is professor A.G. Bolshakov, 2017.
The passage width along this axis is 75-79 meters, length is 860 meters, and the area is 6.6 hectares. The green cross total area is 10 hectares. This constitutes 1/10 of the entire campus area. 60% of this area is occupied by the student park. 40% are occupied by garages and parking lots. In these places, the campus is devoid of contact with the recreational resource, garages and parking lots do not adorn the university. Thus, the green cross formation, which restricts random land use and organizes development, depends on the reconstruction of garages and parking lots. (Please, refer to Fig. 2.) Compact underground parking lot is proposed at the car park at the longitudinal passage northwestern tip.

C. Reconstruction and construction of student accommodations and teacher residences. 3 buildings of the 13 former dormitories serve other purposes now. 8 of the 10 remaining do not meet modern standards, even the temporary housing ones. Two bathrooms serve for 150 people living on one floor. One shower room serves 450 students. One room accommodates 3 people. Non-compliance with the standards makes it necessary to change the corridor-room layout to the corridor-apartment one. Accommodations on the FEFU campus correspond to the standards of three-star hotel [19]. The decompression happens in this case. 200-210 people remain out of 400-450. New residences are needed both for the resettlement of those students who need to be evicted, and for the settlement of those students who need place in dormitory but did not receive one. All first-year students are settled, but they can be evicted in future from residences in view of the priority right of the following first-year students. The shortage of places exists: 2,300 rooms are now available, if you accommodate two people, the 3,500 rooms would be needed, and in case of accommodation of all students in need including foreigners, the 5,000 rooms are necessary. The space doubling is required through the new buildings construction. The problem solution is proposed both by reconstructing existing buildings with change in the layout type, and by new buildings construction between existing ones. Please, refer to Fig. 3. The existing row building type is converted into the block and perimeter one with dimensions of 60-70 meters. Teacher residences should be expanded with buildings on three sites: 1) on the green cross border, 2) in the accommodations block, 3) on the free site at the geological technical school.

D. Technology park new buildings construction. A distinctive feature of the modern technical university is the development of technology parks [15]. The existing technology park does not meet the needs of INRTU. The area of the existing technology park is 2000 sq.m. The twenty times more space is required for the large technical university. For such specialties as aircraft engineering, metallurgy and metal industry, mineral processing, chemical technology, energy, construction techniques and technology, and others require the creation of experimental industrial technologies. The technology park buildings should be large-span. These buildings should resemble industrial workshops with appropriate modern equipment. With large buildings dimensions intended for technology park – up to 50 thousand sq.m. – this is 5 hectares of land for building. Such site may be disposed on the antenna field (10 ha). In case of this site transaction to the Ministry of Education and Science by
the Ministry of Communications of the Russian Federation, technology park construction becomes possible.

E. Objects of socio-cultural and information infrastructure. The university provides strong student creative groups, including academic choir, dance studio, ethno-beat group, fun and resourceful club performances and other concerts and events. These events take place in the assembly hall with adjoining artistic club rooms. Staff meetings are also held here. More developed space is required for student cultural and creative activity – the cultural center for young people, which can be located on the main place of the future embankment. The separate building of the library information center can also be built in the coastal zone due to the university library enlargement. The dense environment typical for urbanized campus can be created on the antenna field [20]. Please, refer to Fig. 4. The absence of swimming pool. It can be built in the continuation of the stadiums axis closer to the coastal line. All this creates the prerequisites for activating the university embankment, which is now limited by the residential low-value buildings location and an antenna field on the river bank. Placing large public buildings in the coastal area on the future embankment creates a new city shape on the left bank, which would be perceived as wide panorama from the city center on the opposite bank.

![Figure 3](image)

**Figure 3.** Residences reconstruction project. Graduation thesis for bachelor degree by Maria Proskuryakova. Supervisor: professor A.G. Bolshakov, 2018.
Figure 4. Information library center project. Graduation thesis for bachelor degree by Daria Kulyandina. Supervisor: senior lecturer R.A. Selivanov, 2018.

F. Formation of the campus internal street network. Internal mobility on campus occurs in limited space and does not meet the campus development strategy. Please, refer to Fig. 5. The street network development is required for the evolution of technology park zone, socio-cultural and sports facilities, new student accommodations and teacher residences. Street network embodies social activity in three aspects: traffic, meetings and meetings avoidance [21], the necessary breaks creation (between garages and public recreational coastal landscapes). Pedestrian traffic targets are entry points to buildings and other objects of attraction (recreational grounds) – destinations. The points of pedestrians’ departure are locations – accommodation entrances, public transport stops. The separation is conditional, since all the locations become the destinations in the return traffic. The traffic takes place on organized streets between all locations in all destinations. This is an effective spatial solution with passing service points in the first floors of the streets area. Or the traffic occupies paths full of turns and twists along lines of unimproved, unattractive and unpopular space. This space should be purposefully formed. The source is the existing locations and destinations positions. Possible street network layout, please, refer to Fig. 2.
Figure 5. The pedestrian activity scheme on existing street network. Prepared by senior lecturer Z.F. Nizamutdinova. Supervisor: Professor A.G. Bolshakov.

Institute of Architecture and Construction students measured the mobility on the main existing campus pedestrian directions. The road traffic intensity is divided into four categories: maximum intensity (1,800 people/hour); intense (1,440 people/hour); moderate (900 people/hour); low (380 people/hour). The scheme in Fig. 5 shows two main types of pedestrian mobility on campus.

a) from public transport to the main academic building entrance. b) from the residences block to the main academic building entrance. The pedestrian directions along the city arterial road of Lermontov Street are defined as longitudinal. The passages from the Lermontov arterial road to the Angara distant area are referred to as transverse. Transverse or distant directions are underdeveloped. They could be evolved in case of coastal zone and antenna field proper development. The embankment will become a channel for effective alongshore traffic.

G. Campus external relations and adjacent territories development. The geological technical school and the Department of Design and Fine Arts site is located on the other side of the main campus through the main street. There free land plot planned for construction and owned by INRTU can be demonstrated. It is necessary and possible to establish connection with this site since it is located in the alignment of Igoshin Street on the green cross transverse passage.

At the distance of 1.5 kilometers from the center of the green cross to the northwest the bosket Zvezdochka is located, a historic landscape with valuable planting and historical artifacts popular for recreation. The green cross longitudinal passage with slight deviation can be continued along Dobrolyubov Street and then...
the campus would be associated with valuable park landscape. Moreover, it provides connection with the adjusting IrGUPS University (Irkutsk State Transport University), since its building is located near the bosket.

If the green cross longitudinal passage is developed in the south-east direction, then it would enter the public center site of the Sverdlovsk administrative district. This pedestrian connection should be conducted through large yard with ground football field, to the Akademicheskaya railway station. The existing tunnel and pedestrian bridge lead from the station to the ice hockey stadium and the regional library.

4. Conclusion

*INRTU campus space type.* The history of universities architectural and planning development shows that in Europe in the Middle Ages they were shaped in the same way as monasteries in the form of dense cloisters closed in square with internal gallery around the courtyards. In the New World, campuses emerged in the suburban areas, out of the city borders. The square opens; the yard is replaced by lawn and park around the building. The complex is loaded with the premises and functions necessary for autonomous life. Simultaneously, universities integrated into urban layout are developing in Europe. Thus, there are two polar models of the university space. The first is dispersed model, when not only residences are moved beyond the pedestrian accessibility of academic buildings, but the academic buildings itself are scattered throughout the city. The second model suggests a suburban campus, the site of which allows compactly accommodating all the necessary functions. The campus core is the combination of accommodations and educational functions. The main mandatory element is the park, recreational space. INRTU campus refers to the third model. It possesses the potential to be full-fledged campus due to the main core: residencies, study and recreation, necessary for relative autonomy. At the same time, in the 1960s, when Irkutsk experienced rapid development, the campus was overgrown with adjusting communities. The result was not only university integrated into the city, but integrated campus, city within the city.

*The advantages of the INRTU campus are suggested by the large university territory located in favorable location on the Angara River coastal area. It provides good transport links to the city and the city center, including the beneficial junction to the Academic Bridge over the Angara River. Directly adjacent to the main street it connects the campus with the whole city which includes three other universities and four microdistricts, including the science campus district, as well as with the historic district of Glazkovo,*
and the suburban electric train station. The internal structure with all nuclear functions completed including good stadium, large library, well-developed student club, suggests the good university level. The campus disadvantages suppose the lack of functions, places and internal street network. The university is located on the Angara banks but does not have access to it. The lack of university embankment can be observed, while the university is allocated on the river bank. The dormitories form entire block, but are morally and physically outdated, do not meet sanitary standards and requirements for students’ comfortable living conditions. The large shortage of technology parks can be also noted. The open recreational spaces are insufficient in size and do not realize the existing spatial possibilities. No library stand-alone buildings, cultural center for young people and water-sports complex are provided.

**Campus development strategy.** The space of large technical university must be completed as orderly and highly organized campus. Fragmentation and breaks could be overcome in the existing layout and arrangement system. The focus should be on the green cross formation and access to the Angara bank with the embankment creation. The accommodations block reconstruction and renovation with new buildings with overcoming the double shortage of space. The teacher residences construction should be done. Doubling the area of academic buildings and increasing the area of technology parks due to the adjacent antenna field development. Creation of public buildings large complex: library stand-alone building, cultural center for young people and water-sports complex including the swimming pool with 50-meter track. The temple should be constructed on the site of the existing parish in the name of Sergius of Radonezh. All this is based on the organization planning of the territory by a regular internal street network with street break of no more than 100 meters. Dense street network will increase the connectivity of the territory to the proposed level. It is necessary to create connections with the adjusting universities, the public urban center and with its own site located on the other side of the main street.

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