Urban topology of university campus

Andrey Bolshakov¹

¹Irkutsk National Research Technical University, department of architectural design, 664074 Irkutsk, Lermontova str., 83, Russia

Abstract. The subject of research is university spatial development. Universities have either a dispersed model of placement of academic buildings, student accommodations and additional facilities, or develop in the form of a campus. A developed campus is characterized by completeness of functions, organized arrangement of places, and effective coherence of parts. The campus has external and internal connections. External connections integrate the campus with urban transport. Internal connections unite parts of the campus into a single whole and provide it with relative autonomy. The useful mobility coefficient in the spatial structure of the university is proposed. Spatial coherence and organization of campus elements is a factor in the university success, at least among other factors that have different origin.

1. The concept of campus urban topology

There are universities predetermining the success of the country and universities driving the globalization. In each major city, the university is essential for the city and region development, because it trains personnel for the economy and culture, and ensures the reproduction of communities. The spatial environment of university can be compact and concentrated on a single site – and this is the case of campus. Universities can be dispersed and then do not form a campus, such as, for example, Irkutsk State University.

If academic buildings, accommodations for students and teachers,
technology parks, cultural and entertainment centers, stadium, gyms, shops and service facilities, as well as recreation facilities are located on one site, one can talk about campus. On campus you can live, work, study, research, spend leisure time, and also receive cultural and recreational services. Thus, a good campus has certain autonomy.

For the full life of the campus, the appropriate space is necessary. The organization of community social life and space forms single inseparable unit. A community is limited by its spatial resources and can be identified by space model. The architectural space provides movement, meetings and allows one to avoid meetings and control access [Hilier]. To provide movement the paths are necessary. To provide meetings the places are needed. The possibility of meetings itself constitutes the community. There are many communities on campus which are organized as hierarchically as heterogeneously. But space is essential for both. Campus space should provoke the meetings possibility. It is presupposed the spatial organization of activity: a) formalized - educational process, research, relations and connections with external interested parties, and informal - communication, club activities, “invisible college”.

The phenomenon of socio-spatial unity of educational, scientific activity, social life of students and teachers in the campus and the suggested spatial organization, embodied in the architectural-planning structure and in the processes of transformation of this space, one calls the university campus urban topology.

2. Examples of campus spatial models

The connection of student accommodations and academic buildings, cultural facilities and recreation (the park and the waterfront) is well provided on the campus of the Far Eastern Federal University. The planning design was developed in 2008 by the Giprogor institute and the Central Research and Engineering Design Institute of Urban Development (architect K.F. Neustroyev). General properties of the campus are provided in Table 1.

Table 1. General properties of FEFU campus [2].

| Property                             | Value       |
|--------------------------------------|-------------|
| Total campus area                    | 80 ha       |
| Total students and staff             | 23,000      |
| Built-up area                        | 650,000 sq.m|
| Area of 11-storey student center     | 40,000 sq.m |
| Rooms for accommodation             | 5,503       |
Lounge area in the student center 3,000 sq.m
Campus permanent residents 10,500
Conference rooms capacity 920 and 750 places
Exhibition area 9,000 sq.m
Waterfront length 1,200 m
Auditoriums 380

**Figure 1.** FEFU campus general plan. Reference: [2].

**Figure 2.** Campus shuttle bus route. [2].

Please, refer to Fig. 1 for the map of FEFU campus. From the above data and maps it can be seen that the project has a balance of functions corresponding as scientific and educational as social and everyday needs of students and teachers. The layout provide good connection of academic buildings with student accommodations – along arched streets connecting the eastern and western lines of residences with the central arc of academic buildings. The campus distinctive feature is unifying center for accommodation and academic buildings representing a large park of about
48 hectares constituted more than a half of the campus. The park and the waterfront of the Ajax Bay are well connected with educational clusters and student accommodations. Internal campus mobility is supported by shuttle buses that provide students transportation from accommodations to academic buildings. The total length of the routes is 6 km. Please, refer to scheme, Fig. 2.

The campus is known to be located in semicircle on Russky Island around Ajax Bay. The city center of Vladivostok is more than 15 km away. The connection is executed by road including two bridges. The FEFU campus represents an example of the suburban type with full autonomy, including medical and cultural services. Researchers mark the hypertrophy of the central block A, where the 2012 APEC summit was held, and a certain constraint of ordinary academic buildings [3].

Another example of campus layout is proposed by the specialists of Chyutin Architects, 2013 [4]. The main idea suggests expanding (doubling) the campus of the Ben-Gurion University of the Negev (BGU) in Beersheba, Israel. Please, refer to Fig. 3. Founded in 1969 the existing university serves more than 19 thousand students. The new campus is located on the opposite side of the existing campus across the railway line. The area occupied is 30 hectares, the proposed building area is 300,000 sq.m.

The campus is divided into zones of: student accommodations, academic buildings, staff housing, laboratories, technology parks and cultural center for all students, teachers, and city residents. The campus also suggests large recreational area. Please, refer to Fig. 4.

Figure 3. The new campus site of Ben Gurion University in Beersheba, Israel. Reference: Chyutin Architects [4].
Figure 4. Clear zoning and location of functional elements in the project of BGU campus, specialists of Chyutin Architects.

Figure 5. Master plan for the construction of BGU campus, winner of the competition, specialists of Chyutin Architects.

All parts of the campus are connected in clear order and proper contact with the surrounding areas. Thus, the cultural center is located in proximity to the residential areas. Technology park buildings are facing the railway right of way. The student accommodations area as well as the teachers’ residential buildings is closely connected with the academic buildings unit. Academic buildings, residences and research laboratories are opening onto large park. In the new campus of BGU, the grid of pedestrian and transport routes unites all functional zones by the shortest distances. Additional comfort for the traffic creates a boulevard connecting the cultural center, student residential area and academic buildings. The boulevard descends
with terraces along the slope on the distance of 8 meters from 306 m to 298 m marks. Please, refer to Fig. 5.

3. General information of Irkutsk universities and campuses

The size, professional and scientific orientation, quantity and equipment of university activities provided with places and spatial connections are important for the university success. It is evident that the effectiveness of teachers and students and managers, the availability of economic and financial resources for development affect the university success. The QS University Ranking suggests the following classification of universities, Table 2, reference [5]. The web-site vuzoteka.ru provides ranking of Irkutsk universities as of 2018. Please, refer to Table 3. In this article it is considered the socio-spatial aspect of university life, which is fundamental to its development.

Table 2. The QS University Ranking.

| Students category | Research category | Age category |
|-------------------|-------------------|--------------|
| XL >= 30000 – extra large | VH – very high | 5 >=100 years – historic |
| L >= 12000 – large | HI – high | 4 >=50 years – old |
| M >= 5000 – medium | MD – middle | 3 >= 25 years – mature |
| S < 5000 – small | LO – low | 2 >= 10 years – young |

1 < 10 years – new

Table 3. Irkutsk universities ranking.

| Ranking | University name | Students | Number of majors | University age | Average score of USE | Russian Federation ranking/Score |
|---------|-----------------|----------|------------------|----------------|----------------------|---------------------------------|
| 1       | INRTU – Irkutsk National Research Technical University | 1799 | 52 | 89 | 57 | 81 / 473 |
| 2       | ISU – Irkutsk State University | 1027 | 56 | 101 | 62 | 122 / 452 |
Considering seven independent Irkutsk state universities, only two have a comprehensive, full-fledged campus, with a full range of functions within one site: Irkutsk National Research Technical University and Irkutsk State Agrarian University named after A.A. Ezhevsky. The limited version of campuses (academic building and student accommodation within one planning element) are suggested in Irkutsk Medical University, and partly in Irkutsk State Transport University. The others universities have dispersed structure with their buildings and residences and other functional facilities scattered throughout the city. In fact, all cities sport, entertainment, recreation, and residential facilities used by students are not part of the university asset and remotely located relative to the academic buildings. Academic buildings are often also distributed and do not form a single spatial-planning complex. For example, academic buildings of Irkutsk State University are scattered around the city (Please, refer to Fig. 7). Academic buildings of BSU are mainly located in one block, but the residential buildings are located in various parts of the city. Fig. 8.

Advantages and disadvantages of the campus. The university campus includes all the necessary objects of educational activities and life necessities. The core of the campus space-layout complex is connection of academic building and residences which should be located within the same plot or one street network element. This is the advantage. Due to the challenge of finding a large free area in big city where university can fit in with all the objects of social infrastructure, many universities are developing on scattered sites embedded in the city structure. Choosing such model with the entire university complex fitting on one site, the campus is carried out to the suburban area, out of the city borders. This is the disadvantage.
Thus, a large site was contributed to Irkutsk Polytechnic University (now INRTU) in 1956, area of more than 100 hectares was located on the city outskirts, free territory, on the left bank of the Angara River. Please, refer to Fig. 6. However, it was a period of city rapid growth, when the first hydropower plant was built on the Angara river, the building of Academgorodok district had promptly begun beyond the Polytechnic University site, and so did the construction of seven settlements of hydropower plant builders further up the Angara river. Therefore, the university large site acquired surrounding community.

4. Campus location conditions regarding public transport stops and connections of residences with the academic building

According to the conditions of city location, its transport system and public transport stops, the Irkutsk universities look as follows. Please, refer to Fig. 6-11. The distances from the main academic buildings of Irkutsk universities to public transport stops are as follows. Please, refer to Table 4. The shortest pedestrian paths from public transport stops to the ISU academic buildings in the city center. The schemes show only part of the buildings. The other part is located in the Sverdlovsk administrative district. The circle diameter describing the presented placement area is 1.8 km. Please, refer to Fig. 7.

Figure 6. The shortest pedestrian paths from accommodations to academic buildings and from public transport stops to the main facilities of INRTU. Drawing by Z.F. Nizamutdinova. The average distance from public transport stops to the INRTU entrance is 150 meters.
Table 4. Average distances from public transport stops to educational buildings.

| Institution | Average Distance |
|-------------|------------------|
| INRTU       | 150 meters       |
| ISAU        | 180 meters       |
| BSU         | 220 meters       |
| IrGUPS      | 500 meters       |
| ISMU        | 650 meters       |

Figure 7. Irkutsk State University. Drawing by Z.F. Nizamutdinova.

Figure 8. BSU. Drawing by Z.F. Nizamutdinova. The shortest distance from public transport stops to the BSU academic buildings is 220 meters.
Figure 9. IrGUPS. The academic building location (single complex) relative to public transport stops. Drawing by Z.F. Nizamutdinova. The shortest distances from public transport stops to the main building entrance: average distance from the railway station and from the bus and trolleybus stop - 500 m.

The distance from the public transport stops to the main academic building mainly concerns students who are not living in campus accommodations and teachers living outside campus. For students who are campus residents, the most significant daily traffic is from the accommodations to the building. Table 5 presents data on the average shortest distances from residences to academic buildings of part of Irkutsk universities.

Figure 10. ISAU – Irkutsk State Agrarian University named after A.A. Ezhevsky. Drawing by Z.F. Nizamutdinova. The average shortest distance to the academic building main entrance is 180 m.
Figure 11. Irkutsk State Medical University – ISMU. Drawing by Z.F. Nizamutdinova. The average shortest distance from public transport to the main building entrance is 650 meters.

Table 5. Pedestrian work values in Irkutsk universities.

| Pedestrian accessibility on the way from residences and recreational facilities to the academic building | INRTU | BSU | IrGUPS | ISMU | ISAU |
|-------------------------------------------------------------------------------------------------|-------|-----|--------|------|------|
| Residence – academic building (in pedestrian availability) | 580 m  | –out of pedestrian availability to academic buildings | 230 m  | 440 m |
| Recreation zone – academic building | 190 (Belochka square); 1390 (bosket Zvezdchka) | 262 (Gorky square) | 136 m (bosket Zvezdchka) | 192 m (Alexandra square on Gagarina boulevard) | 490 m (bosket on Topka bay bank) |
| Student accommodation residents (as 30%) | 5,400 people | 4,300 people | 2,500 people | 1,200 people | 1,600 people |

5. The ratio of external and internal pedestrian mobility in university campuses
The ratio of external and internal pedestrian mobility in Irkutsk university campuses are represented in Table 6.

**Table 6.** The ratio of external and internal mobility in Irkutsk university campuses.

| Pedestrian mobility | INRTU          | BSU            | IrGUPS         | ISMU           | ISAU           |
|---------------------|----------------|----------------|----------------|----------------|----------------|
| External mobility   | 150m x 12,591  | 220m x 10,083  | 500m x 6,378   | 650m x 3,286   | 180m x 3,510   |
| (from public transport stops to academic buildings) M out | 1,888,65 people/m | 2,218,260 people/m | 3,189,000 people/m | 2,135,900 people/m | 631,800 people/m |
| Internal mobility   | 580m x 5,400   | 0 m x 4,300    | 0 x 2,500      | 230m x 821     | 440m x 1,600   |
| (from campus residence to academic building) M ins | 3,132,00 people/m | 0 people/m  | 0 people/m | 276,000 people/m | 704,000 people/m |
| Useful mobility     | 3,132,00 / 0   | 2,218,260 / 2,135,900 | 3,189,000 / 631,800 | 276,000 / 1,12 | 704,000 / 1.1 |
| M ins/M out         | 1,888,65 / 0   | 0 / 0         | 0 / 0          | 0.12           | 1.1            |

The internal mobility of accommodation-work connection occurs only on campus. Universities with no residences within pedestrian availability of academic buildings do not have such activity or appropriate environment.

Comparing the upper row figures (external mobility) it is clear that the approximate location relative to public transport stops, even with a large student population, puts the university in advantageous position in terms of external pedestrian work. The comparison between INRTU and IrGUPS is characteristic – in consideration of remote location from the stops, even with half the number of students, the latter spends 40% more pedestrian work than the one from INRTU.

The comparative analysis of mobility indicators within the Irkutsk universities campuses demonstrates that there are no accommodation-study internal connections within pedestrian availability of such universities as BSU and IrGUPS. And universities that provide campuses, such as INRTU, ISMU and ISAU, depend both on the average campus communication range and the number of student residents in terms of their internal mobility.

The large number of students living in residences increases social activity and the possibility of communities’ formation at the university due to the greater chance of meetings in campus pedestrian spaces. Time to move along the accommodation-work (study) route significantly reduces. Unproductive
time expenditures for transport traffic are excluded. External mobility – the students and teachers traffic from stops to the academic buildings demonstrates the organization degree of university-public transport system connection.

The useful mobility coefficient indicates the priority of internal traffic over external. The urban transport usage and approaches from bus stops to the academic buildings are unproductive. Traffic within the campus is the driver of the spatial environment organization of the campus itself, if there is one.

The given campus patterns of Irkutsk universities provide the organization degree of campuses or at least of the academic buildings group. Revealed patterns are dense and ordered, axial and lattice, dispersed loose and dispersed.

Conclusion

The university campus is a compact unit of places providing scientific, educational, residential, cultural and recreational activities. The minimum set of functions confirming that university provides a first-generation campus is the main “study-science-residence” group. The connection between student accommodations, teacher residences and academic buildings should be within pedestrian availability, and should not exceed 800 meters. Additional functions: cultural, entertaining, shopping, sports, recreational suggest the next steps in university campus development if they are located within the single planning element of the city.

The campus is characterized with external and internal spatial connections. External connections are paths from public transport stops to the main academic building. The average distance of pedestrian connection here demonstrates the campus integration degree with the urban transport planning. Internal connections are the paths from student accommodations and teachers residences to academic buildings. Consequently, the external and internal mobility of the campus could be discussed. The pedestrian work performed in this case is equal to multiplying the average distance product of connection by the number of people involved in external and internal traffic. Internal mobility is useful work. Entrances and campus approaches are time consuming. Based on these values correlation, the campus useful mobility coefficient is suggested.

The definite group of factors affects the university success including the campus spatial organization degree. The Irkutsk universities ranking
demonstrate the leading position occupied by Irkutsk National Research Technical University, which among Irkutsk universities has the most complete and coherent campus. No doubt such factors as the research activity level of employees, the average score of USE university applicants, the annual university budget are indirectly related to spatial organization and may have independent significance, as in Irkutsk State University. However, the campus organization in terms of completeness, connectivity, and organization density of basic and additional functions in the university development strategy is significant factor.

References

[1] Hillier B, Hanson J. The social logic of space. Bartlett School of Architecture and Planning University College London.- Cambridge University press, 1984.- 281 p.
[2] FEFU campus on island Russky, Available at: https://www.dvfu.ru/about/facts-and-figures/ Accessed March, 21 2019.
[3] V. Moor. Universal space of the Far Eastern Federal University. Project Baikal, 2015, No. 44, pp. 128-129
[4] Chyutin Architects. BGU North Campus, Ben Gurion University, Israel. 2013 Available at: https://www.chyutin.com/content/bgu-north-campus?ref=nid599&cat=. Accessed March, 30 2019.
[5] K. Lidin. University Rankings-2. The Search of Higher Education Paradigm Against the Global Crisis and Balkanization Background. Project Baikal, 2015, No. 44, pp. 104-107
[6] Irkutsk University Ranking. vuzoteca.ru. Available at: http://vuzoteca.ru/%D0%B2%D1%83%D0%B7%D1%81%D0%BA%D1%83%D1%82%D1%81%D0%BA (Accessed 12.03.2019)