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1.4 Architectural formation of a new volume within an existing campus: reconstruction of university buildings

Introduction

The reconstruction of university buildings involves numerous challenges: the need to bring facilities up to modern educational, technical, and safety standards while preserving their architectural and historical value, minimizing costs, and reducing environmental impact. Due to the large building areas and diverse functions (lecture halls, laboratories, libraries, museums, dormitories), campus projects typically combine measures ranging from local structural reinforcement to full-scale reconstruction with partial replacement of building volumes. Research and practical case studies show that retrofitting and adaptive reuse are often more technically and financially efficient than demolition and new construction, especially when considering life-cycle cost and carbon footprint.

Successful renovation of university facilities creates qualitatively new spaces that enhance opportunities for learning, research, and interaction. As a result, the campus receives an updated infrastructure that meets modern requirements and ensures long-term functionality.

Possible approaches to restoration work:

- repair works - minimal interventions aimed at restoring cladding, windows, and roofing while preserving historical authenticity;
- structural strengthening - works focused on increasing the load-bearing capacity of the building or its specific structural elements;
- energy-efficient measures - comprehensive upgrades such as insulation of the building envelope, replacement of engineering systems, and integration of ventilation with heat recovery;
- adaptive reuse - transformation of the building’s function ;
- partial reconstruction (replacement, extensions) - preservation of the main structures with the addition of contemporary volumes;

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From the perspective of engineering modernization, universities are among the most energy-intensive types of public buildings. High heating and ventilation demands of laboratories, server rooms, computer clusters, and lecture halls with large occupancy require the integration of modern, highly efficient systems. Reconstruction typically includes zoning of ventilation units, local heat recovery devices, smart systems controlling air exchange based on CO_2 levels and humidity, low-temperature radiator networks, or fully air-based systems. Electrical network upgrades involve implementing high-capacity channels for laboratory equipment, next-generation distribution boards, uninterruptible power supply systems, and structured cabling networks.

Key technical issues in the reconstruction of university buildings:

- incompatibility of materials (old masonry, lime mortars, modern cement-based repairs).
- non-compliance with modern fire safety and evacuation standards (need for additional exits, fire-resistant shafts, smoke extraction systems).
- seismic vulnerability - many historical buildings require major strengthening measures (monolithic diaphragms, new transverse shear walls, reinforced belts).
- engineering networks - integration of modern heating/ventilation/air-conditioning systems and IT infrastructure into limited spaces.
- architectural and historical preservation requirements — demand for minimal intervention into original materials and elements.

Practical tools and technical solutions:

- diagnostics of the technical condition: non-invasive methods (ultrasound, infrared imaging), testing of masonry samples, on-site load testing.
- structural solutions: installation of external or internal steel frames, strengthening of damaged elements, injection methods for masonry crack repair.
- façade retrofits: ventilated façades, internal insulation with controlled dew point, use of breathable materials for historical façades.
- modular ventilation units, local energy nodes (heat pumps, cogeneration), zoning of systems for phased implementation.

Modern university buildings function not only as educational institutions but as extensive scientific-educational complexes. This requires adapting the spatial structure to multifunctionality and changes in pedagogical strategies. The reconstruction of buildings includes the creation of hybrid learning spaces, open-type laboratory clusters, informal learning zones, makerspaces, prototyping workshops, and integrated research platforms. Planning solutions must ensure the possibility of rapid spatial transformation, modular furniture layouts, mobile IT stations, integration of multimedia support systems, and adaptive lighting.

The role of acoustic design is increasing. Libraries, large lecture halls, and group work environments require proper management of acoustic parameters -reverberation time, sound absorption, and sound insulation between rooms. During reconstruction, sound-absorbing panels, suspended acoustic modules, materials with variable acoustic response, and multi-layered floor/ceiling systems are used. A particular challenge is creating a comfortable acoustic environment in corridors and common areas, where noise levels are often highest.

Inclusivity is an integral component of the reconstruction of educational buildings. The need to create universal access includes reconfiguring entrances, installing elevators in buildings that historically did not have them, widening corridors and door openings, providing barrier-free sanitary facilities, reducing floor level differences, and integrating tactile and visual wayfinding systems. In older buildings, such measures often face spatial and structural constraints, requiring individual technical solutions - external elevator shafts, mobile platforms, or localized reconfiguration of specific areas.

Reconstruction of universities is impossible without the modernization of internal mobility and wayfinding. As the areas of educational and research complexes increase, internal transport communications within and between buildings become especially important. Integrated navigation systems are implemented using indoor positioning sensors, QR-coded classrooms, multi-format signage, and digital information panels. Managing large flows of students requires optimization of vertical circulation: creation of new stairwells, widening of elevator lobbies, and redistribution of movement routes to avoid narrow "bottlenecks." This is critical in buildings where historical layouts were not designed for modern usage intensity.

Architectural lighting plays an important role in identifying university spaces in modern reconstructions. Buildings are equipped with dynamic LED lighting systems that adapt to events - conferences, celebrations, presentations. Interiors use multi-zone, scenario-based lighting for classrooms, laboratories, and coworking areas. This enhances not only the aesthetic quality of the space but also the ergonomics of the educational process: proper light temperature and illumination levels directly affect user productivity and comfort.

University campuses form complex landscape-spatial systems, so reconstruction also encompasses the adjacent territories. Important measures include relocation of utilities, modernization of underground networks, installation of surface water drainage systems, strengthening of the soil base for new pedestrian areas, and creation of barrier-free routes. The role of landscaping and climate solutions is increasing: pergolas, green roofs, local phytofilters, and water features to regulate the microclimate in courtyards. Such interventions enhance campus resilience to overheating and create a comfortable environment between buildings.

A comprehensive approach to the reconstruction of university buildings allows the building to be considered not as an isolated system but as part of an integrated campus. Planning takes into account external communications, landscaping, accessibility, student flow mobility, and potential for future development. An important aspect is the formation of a phased strategy: dividing works into stages to ensure uninterrupted educational processes, temporary repurposing of buildings, and the possibility of modular implementation. This approach minimizes risks and ensures adaptability at all stages of reconstruction.

Concept

In our concept, we combine preserved elements of the past with new contemporary solutions. Existing columns are retained as a material symbol of resilience — they withstood impact but did not lose their support. In our project, these columns become not just a structural element but a sign of memory and endurance — a reminder that the university continues to stand on its solid foundations, even after attempts to destroy it.

The new volume is made of light glass, symbolizing openness and the pursuit of development. It is protected from above by a steel suspended façade, reminiscent of armor — a symbol of strength and safety. In this way, we combine the memory of wartime events with a forward-looking vision, creating a space that reflects recovery and resilience. All these solutions form a modern volume, dynamically integrated into the campus space and highlighted by the steel suspended façade. The architectural composition of the new building is shown in Figure 1.

Figure 1: Exterior view of the academic buildings [made by the authors]

The master plan

The master plan envisions the formation of a coherent functional-spatial complex, within which the university buildings — 7(1) and 11(2) — are connected by a two-storey passage (3). The location of the passage provides convenient pedestrian links between the buildings and integrates them organically into the existing campus structure.

The planned area has rationally organized zones with different functional purposes. A separate area is provided for car parking (7), a specialized section for technical vehicles (6) used in the university's educational and research activities, as well as technical facilities (5), which include a transformer substation, a boiler room, and an electrical switchgear room, ensuring uninterrupted operation of the complex's engineering systems. Such zoning allows for optimization of traffic flows and minimizes conflicts between pedestrian and vehicular routes.

An important component of the planning structure is landscaping, arranged along the pedestrian connections. Green plantings serve recreational and ecological functions, improve the microclimate, and create a comfortable environment for students and staff.

Beneath the planned passage, a standard fire truck access route is provided (3). The geometric parameters of the passage and the height levels comply with fire safety requirements and ensure operational access for emergency vehicles to all parts of the complex.

Together, these solutions provide effective interaction between functional zones, safe use of the site, and harmonious integration of new elements into the overall spatial structure of the campus. The master plan layout of the proposed site is shown in Figure2.

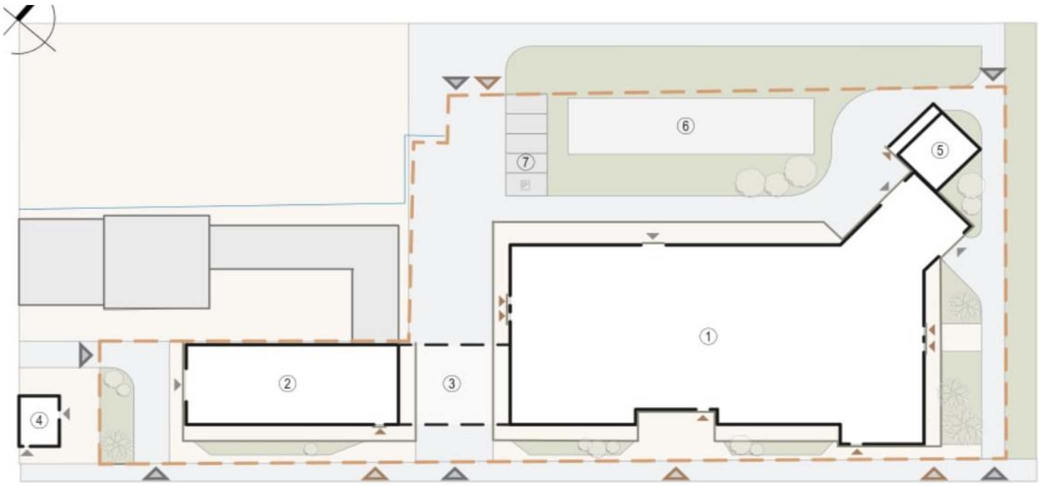

Figure 2: project master plan [made by the authors]

Planning decisions of the project

Workshops

The seventh building includes two large-scale educational and production workshops designed for laboratory work and practical exercises related to oil and gas extraction technologies. The spaces are equipped with appropriate technical installations, including pump units, drilling equipment simulators, and auxiliary mechanisms.

To enable the movement of heavy components of experimental equipment, both workshops are equipped with overhead cranes integrated into the load-bearing steel structure system. Gates are also designed to allow the equipment to be brought inside. This arrangement allows for installation, adjustment, and maintenance of equipment without the use of external machinery. The workshop layout can be seen in Figure 3.

One of the workshops features an observation balcony on the second-floor level (shown in Figure 4), providing visual supervision of the educational process and allowing students to observe demonstration operations under safe conditions. This spatial organization meets the requirements for visibility and openness in technical university teaching.

The structural system includes a perforated beam that supports part of the floor slab. The use of a perforated profile reduces the beam's self-weight and optimizes load distribution without compromising its load-bearing capacity.

The exterior walls of the workshops are fully glazed. This scheme ensures maximum natural lighting of the work areas and creates visual openness — processes occurring inside can be observed by both students and visitors outside the campus. This aligns with modern trends of demonstrating technological processes in educational institutions. The workshop interior is shown in Figure 3, and the workshop floor plan is shown in Figure 4.

Figure 3: Interior view of the workshop from the east side [made by the authors]

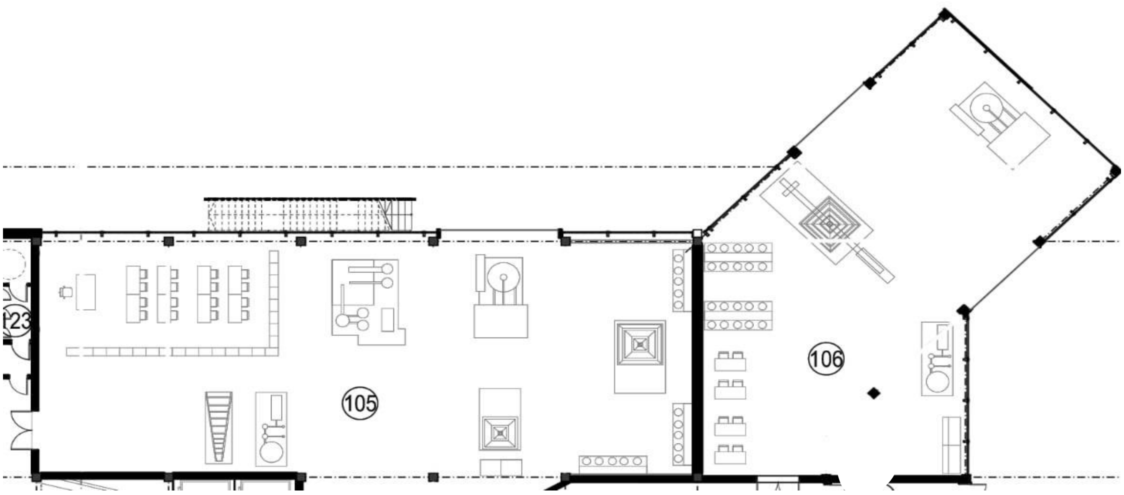

Figure 4: Floor plans of the workshops in Building 7 [made by the authors]

Laboratory

The 11th building houses an educational laboratory with gates that allow access for large-scale equipment. The space combines an area for experimental equipment and zones for conducting classes. Three sides of the laboratory are fully glazed, providing maximum natural lighting and comfortable conditions for educational and practical work. The laboratory floor plan is shown in Figure 5.

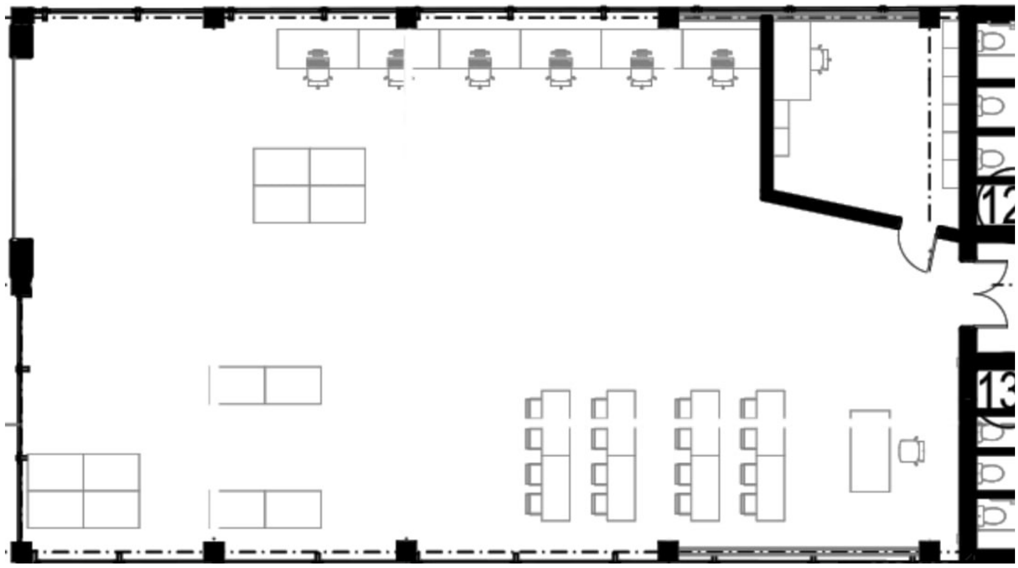

Figure 5: Floor plan of the laboratory in Building 11 [made by the authors]

Educational and Administrative Areas

The 7th and 11th buildings include a complete complex of educational and administrative spaces, ensuring an effective learning process and the organizational activities of the university.

The project provides 12 classrooms of various functional purposes, located exclusively in the 7th building and integrated into the volume of the passage between the buildings.

These include:

- 3 lecture halls designed for large-group classes and equipped with modern visualization systems.

- 2 laboratory classrooms intended for practical research and work using specialized equipment.
- the remaining rooms are classrooms for practical exercises, organized for small- and medium-sized student groups.

All educational spaces are characterized by a high level of natural lighting, ensured by rational placement within the facades and the use of large glazed surfaces. Some classrooms are equipped with preparation rooms, allowing for efficient material preparation, equipment storage, and demonstration of practical lessons.

One classroom is integrated into the passage space between the buildings, facilitating efficient use of space and enhancing functional connectivity between campus learning zones. The main portion of the classroom stock is concentrated in the 7th building, which houses technical education spaces.

In the 11th building, the second floor contains exclusively administrative offices for departments, faculty, and management staff. The layout includes offices, meeting rooms, and auxiliary zones that ensure organized work for personnel and effective interaction with educational units.

Additionally, both buildings include a large assembly hall and a conference hall, used for scientific events, presentations, student gatherings, and public lectures. These spaces are equipped to meet modern multimedia and communication system requirements.

The spatial organization of educational areas located in different buildings of the complex is shown in Figures 6 and 7.

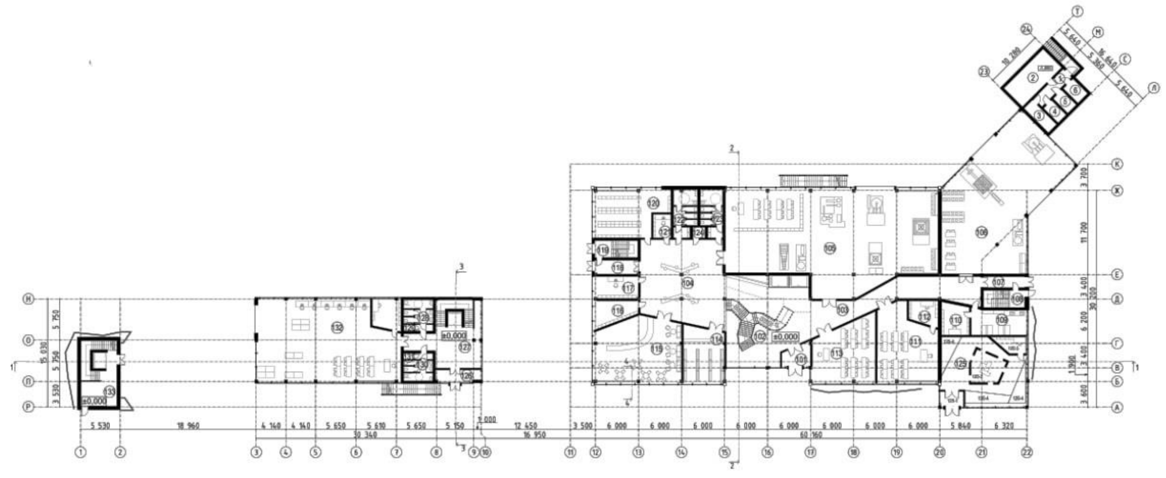

Figure 6: plan of the ground (first) floor [made by the authors]

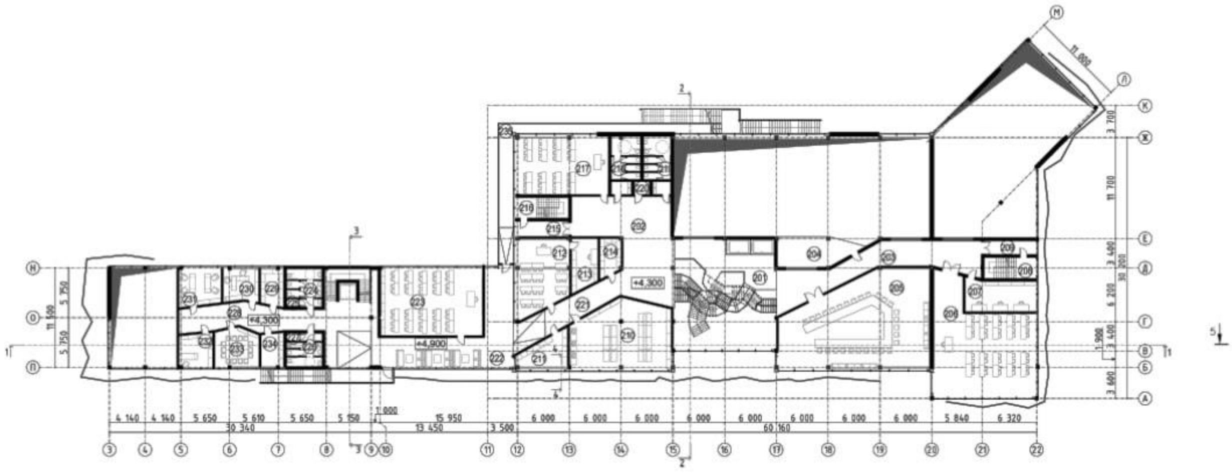

Figure 7: plan of the second floor [made by the authors]

Student Space

The student space occupies the third floor of the 7th and 11th buildings, as well as the passage between them, forming a single integrated zone for student life and learning. The layout combines different functional areas: open spaces for socializing and relaxation, individual workstations for independent study, and specially equipped rooms for group work and collaborative projects.

Organizing the student space over such an area allows for effective integration of educational and social functions, stimulating communication, idea exchange, and the development of creative and research skills. Thus, the space becomes not only a place for learning but also an important element of student life, supporting interaction among students and creating favorable conditions for completing educational and project tasks.

The spatial solution of the student environment with multifunctional zones is shown in Figure 8.

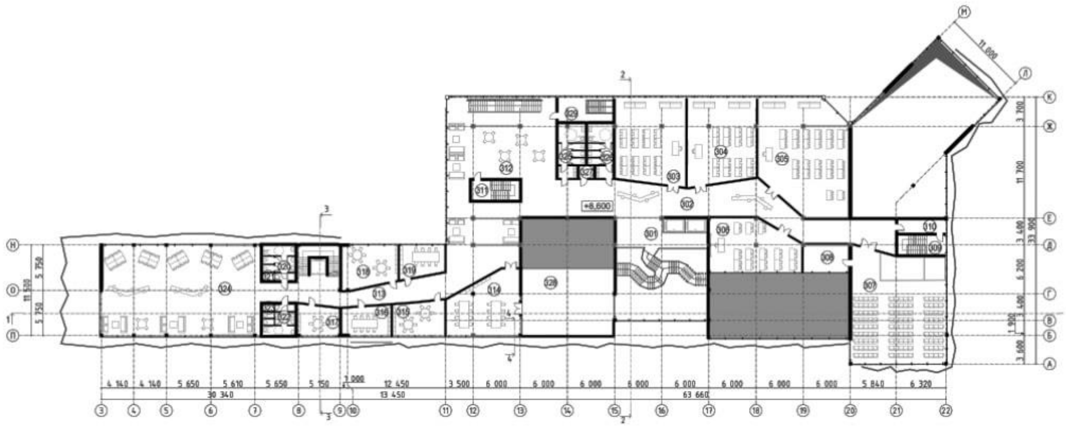

Figure 8: plan of the third floor [made by the authors]

Cafe

On the first floor, a compact café is provided, operating in a ready-meal service format. Food is not prepared on-site — products are delivered fully prepared. The café space is organized for quick service and short breaks, creating convenient conditions for relaxation and informal interaction between classes. The layout of the café interior with functional zoning is shown in Figure 9.

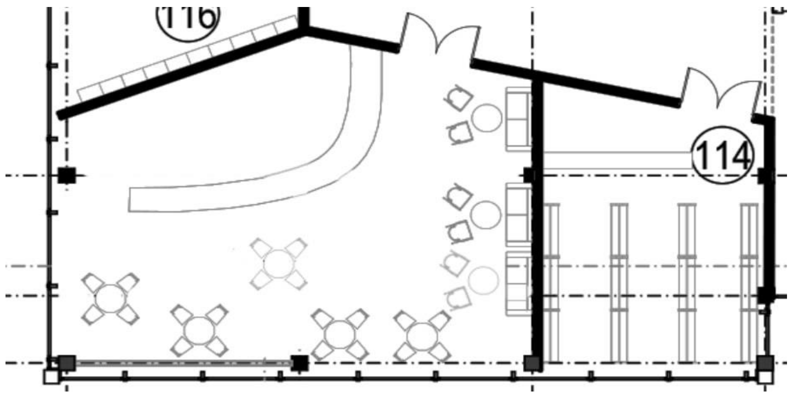

Figure 9: Floor plan of the café in Building 7 [made by the authors]

Museum

The missile strike museum is located on the first floor and has a separate entrance, providing open access for all visitors. Its space is organized around a quiet zone and an exhibition area arranged along the perimeter. This structure allows for a reflective experience of the event, combining an atmosphere of focus with an informative presentation of materials. The museum layout is shown in Figure 10.

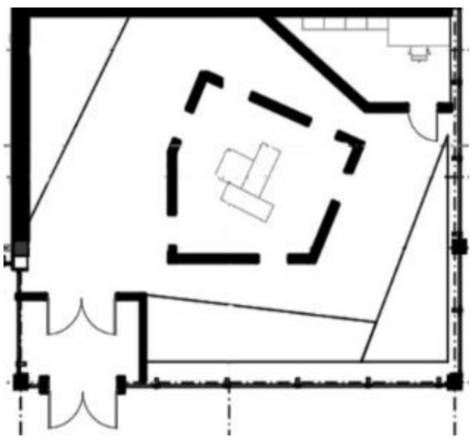

Figure 10: Floor plan of the museum in Building 7 [[made by the authors]]

As a result of the reconstruction, the campus receives a modern spatial identity and increased operational efficiency: pedestrian connections are optimized, universal accessibility is ensured, engineering systems are modernized, and the new architectural form is harmoniously integrated into the existing environment. The updated complex not only restores the full functionality of the university after the destruction, but also brings it to a qualitatively new level of educational infrastructure, forming a sustainable and future-oriented academic center capable of meeting modern and promising challenges.

Functionally updated workshops, laboratories, and administrative premises significantly expand the university's capabilities in training specialists and conducting research in the field of oil and gas technologies, while flexible classrooms and multifunctional student space support modern pedagogical formats and teamwork.

Conclusion

The reconstruction of the complex not only restores the damaged spaces, but also rethinks their architectural essence, transforming the damaged buildings into a new integrated learning volume that symbolizes resilience and recovery. Preserved structural elements – in particular the surviving columns – become visible markers of continuity, while the new glass volume and steel suspended facade system reflect openness, technological progress and enhanced security.

The coordinated spatial and functional design of all elements of the complex forms a coherent architectural structure that supports the diverse needs of the university community. Classrooms, administrative offices, student spaces, the food zone, and the museum function as complementary components of a unified environment. They provide comfortable conditions for educational, research, communication, and social activities, creating a balanced space that combines learning, relaxation, and cultural reflection.

Thanks to thoughtful architectural logic and clear zoning, the complex becomes not only a place for acquiring knowledge but also an important element of the urban and social context, strengthening the connection between the university and the wider community.