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Erasmus+ Programme Key Action 2 Cooperation Partnerships  
for Higher Education (KA220-HED)

Agreement number 2023-1-RO01-KA220-HED-000155412

European Network for Additive Manufacturing in Industrial Design for Ukrainian Context

Summer School – National University of Science and Technology POLITEHNICA Bucharest, Romania, 8-17 July 2024



# AMAZE e-toolkit manual for digital learning in producing complex design industrial parts: module 2 - *AUTODESK Revit*

## LECTURE

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This module is devoted to the reconstruction of an industrial building, namely a brewery in Chernivtsi, which was carried out in Revit. In the process of developing the model, a partial reconstruction of the existing building was proposed with the additional construction of a new building nearby.

The reconstruction of such an industrial facility is a complex project that required solving a number of specific tasks. Among them:

- finding the best architectural and structural solution, taking into account the changed functionality of the building and design standards;
- replacement of technological and related engineering equipment with modern equipment and the use of existing holes and shafts for laying the building's utility lines;
- decisions on dismantling and replacing part of the building structures.



The current condition of the brewery





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## Brief historical background

The first joint-stock brewery in Chernivtsi was built in 1869- 1871.

The brewery is located north of the city centre, on the right bank of the Prut River, in close proximity to the railway and train station.

It was founded by local entrepreneurs Heinrich Wagner, Markus Zucker, Isaac Rubinstein and architect Gregor.

"Bavarian" beer was exported to Romania, Germany and Austria. Barley from Romania and Bessarabia, hops from the Czech Republic, and water from local artesian wells were used in its production. The development of the industry in western Ukraine is also evidenced by the fact that in 1911 Bukovyna and Lviv brewers united in the Galician-Bukovyna beer cartel. This meant a monopoly on the production and sale of beer in the region.

The facade of the production building is designed in the classicist style and is decorated with characteristic pilasters. To the left of the main building are two buildings with a gate between them. The balcony fence of the building to the right of the gate contains pseudo-gothic elements. The arched windows of the building to the left of the gate refer to the Romanesque style.



Historical photographs of the brewery



Beer brands produced in Chernivtsi





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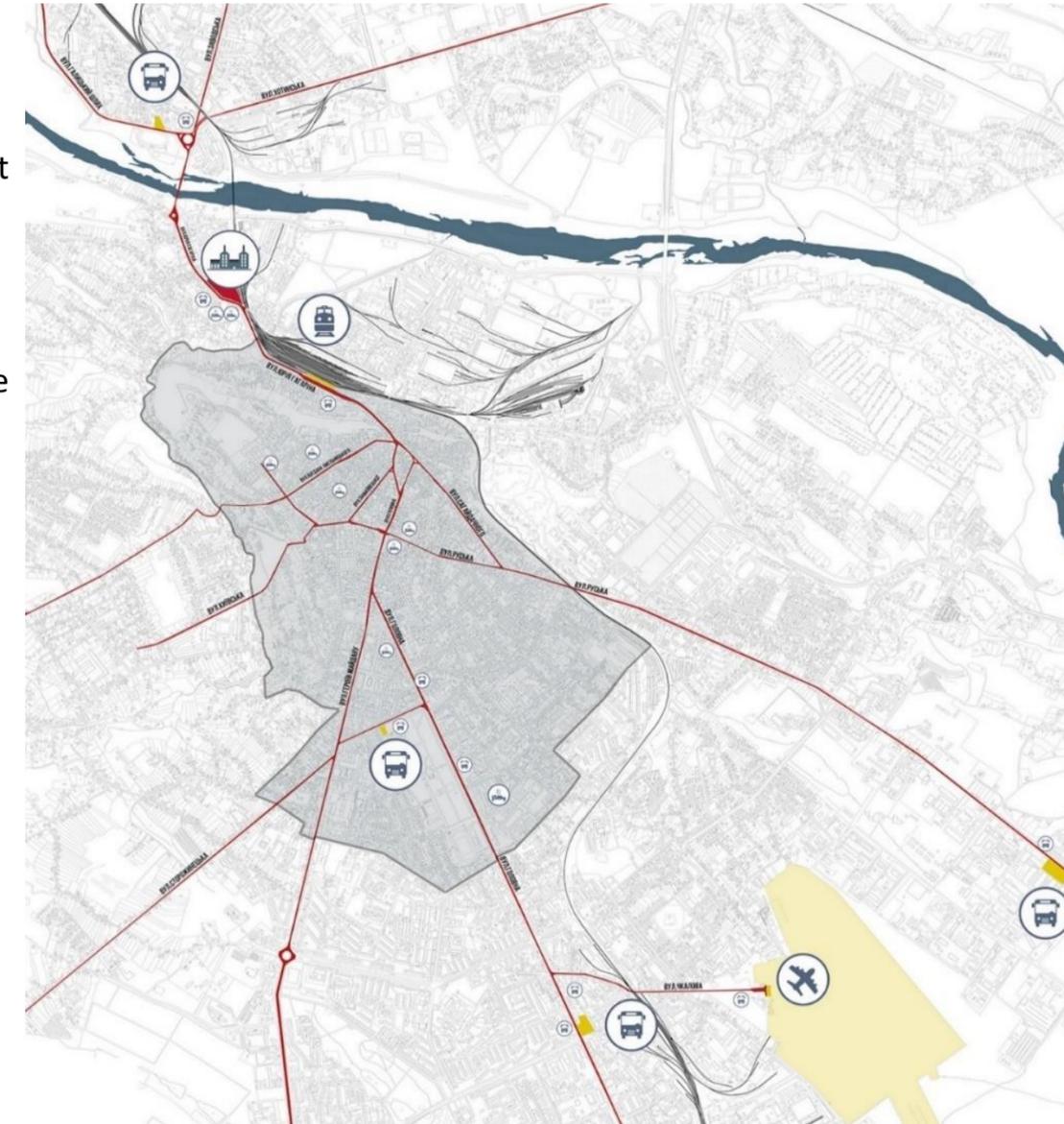


## Current state of the territory and the building

Nowadays, the factory is a closed and abandoned space. The decline of this industrial building due to a number of factors has turned it into a depressed and non-functional territory.

**However, this building has historical and cultural value for the region.**

The factory's territory is located at the intersection of all major transport routes - the main arteries of Chernivtsi, which connect the site with almost all districts of the city and border the historic part of the city.



Situation scheme. Location of the project site in Chernivtsi





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Vokzal'na Street (formerly Gagarina Street), where the factory is located, has a large daily traffic of cars and public transport from/to the historic city centre.

There is a railway station, a bus station and public transport stops close to the research area. This indicates accessibility to the future public facility.







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## Purpose and functions of Autodesk Revit

Autodesk Revit is a software package that implements the principle of Building Information Modeling (BIM) to create visualisations and drawings of plans, sections, details, and other tools for building design.

The building information model contains information about the construction of the project, its dimensions, stages, and quantitative characteristics of the elements.

Drawings created with Revit are not a collection of 2D lines and shapes. Any view, whether two- or three-dimensional, detail, or specification is part of the same information model.

The software includes easy-to-use conceptual design tools. It also allows you to visualise the model. Additionally, Autodesk Revit offers such functions necessary for architectural and design work as energy consumption calculation and structural analysis with the ability to perform static calculations in the cloud, especially important is the creation of a two-way connection between the model and various analyses and automatic updating of the model based on the results.



<https://www.vaillant.it/professionisti/per-la-progettazione/bim/>





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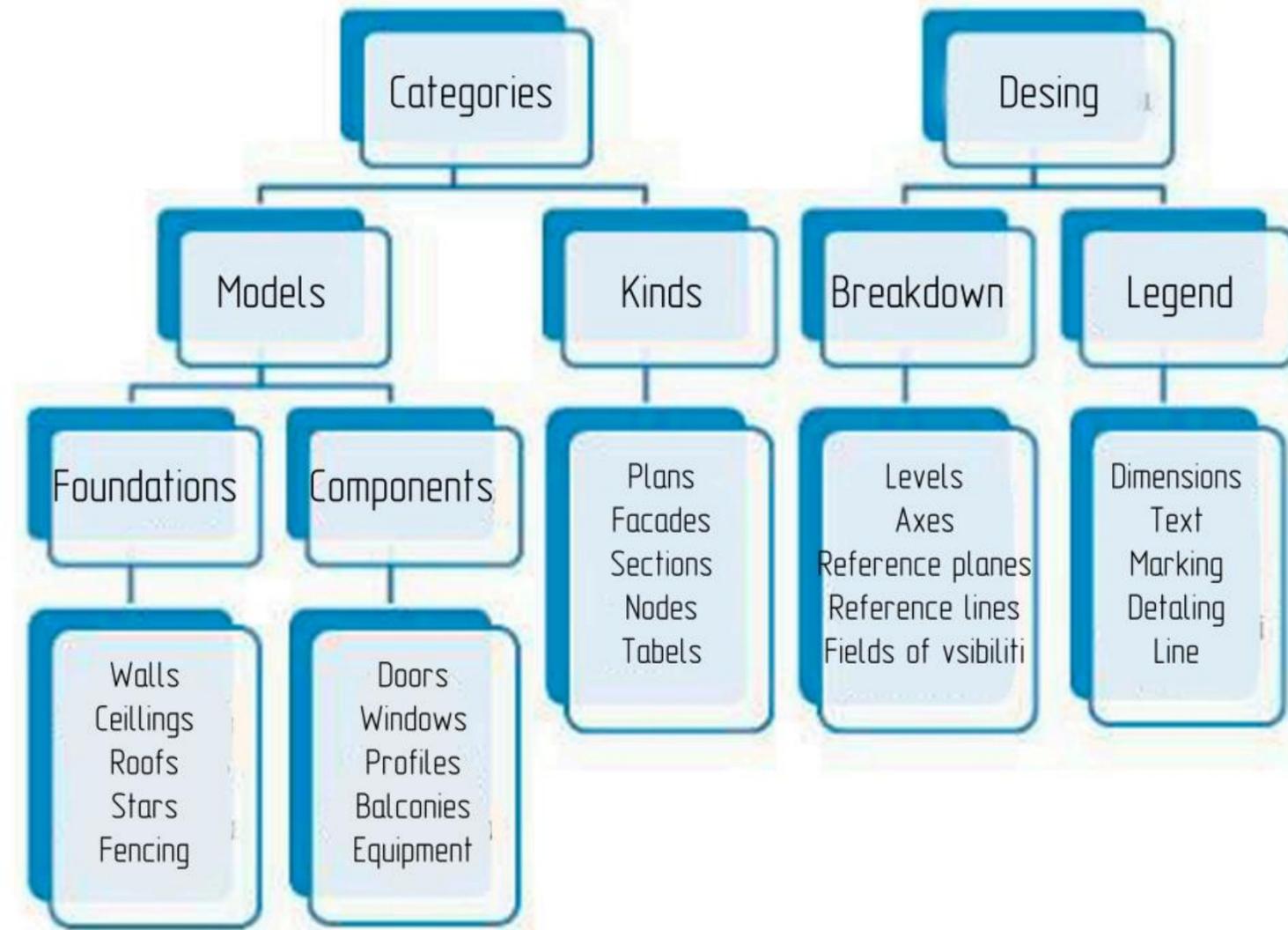
A feature of Revit, in comparison with its closest competitors, such as Graphisoft Nemetschek Group, Nemetschek Allplan, Bentley Microstation, is a new concept of element structure and the use of a hierarchical project structure.

At the very least, it does not have the usual means of distributing geometry - Layers - but instead has a whole hierarchy of Categories, Families, Types and Elements, as well as several methods for managing them.

Category is the systematic division of Autodesk Revit data by purpose (Wall, Window, Equipment, etc.). There are categories depending on the use: Models, Views, and Design. They have an individual set of properties and parameters, as well as behaviour and interaction conditions. Categories cannot be created and edited by users.

Model categories include, as a rule, three-dimensional elements and are conventionally divided into Basic (Walls, Ceilings, Roofs, Stairs, Fences, etc.) and Components (Doors, Windows, Profiles, Equipment, etc.).

The design categories usually include two-dimensional elements and are divided into Breakdowns (Levels, Axes, Reference planes, Reference lines, etc.) and Symbols (Dimensions, Text, Labels, Detailing, Lines, etc.).



Categories





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### Building Information Model – BIM technology:

- model is the simplest representation, a 2D or 3D model that is entered by the user into the design space.
- information means that models in the design space are endowed with certain properties, in Revit these properties are called parameters. The difference between BIM programs and CAD programs is that the user can edit these parameters, as well as enter their own parameters for objects and change them during the design process. For example, the physical parameters of an object are width, length, height, material, etc., and the user can also enter parameters such as manufacturer, price, etc.
- building - the final result of the design process, which is a building - a set of various objects with their own properties that create a complete structure. As opposed to a conventional 3D editor, in a BIM program, each object is defined by the program or the user as a specific object with a specific function, rather than as a collection of polygons and planes.



<https://parametric-architecture.com/building-information-modelling-bim-dimensions-4d-5d-6d/>





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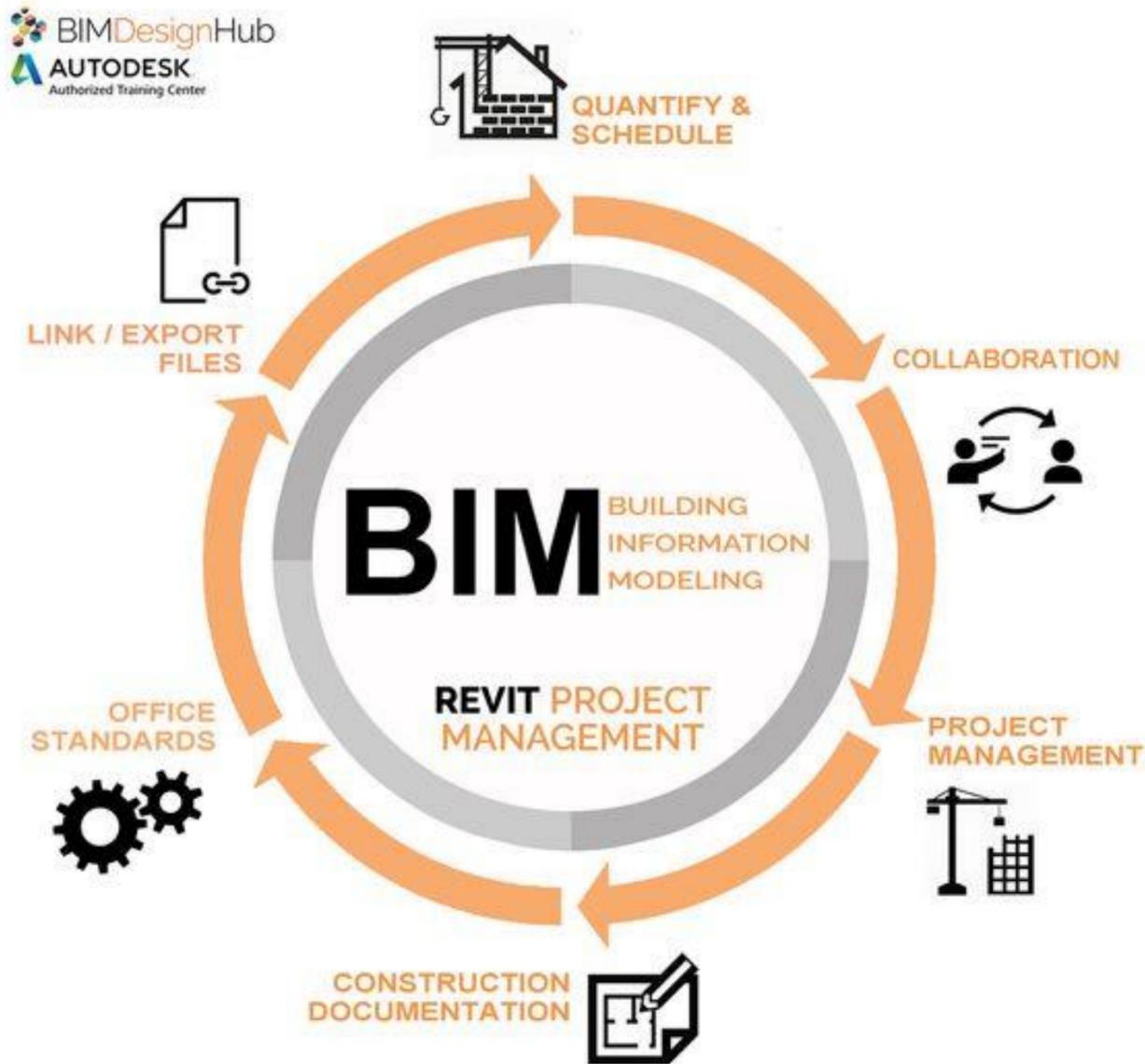
When you create a project in Revit, stage is important. Assigning elements to certain stages can be used to filter the visibility of these elements; stage is also reflected in the specifications. Stages are the stages of a project and reflect the creation and life cycle of the entire building and/or its elements.

Building a model can be started in one of two ways: by creating a conceptual model and then converting its parts into building elements (walls, roofs, etc.), or by creating a model from standard elements. In both cases, further work on refining the model will include the addition of typical elements - walls, partitions, roofs, windows, doors, etc. Also, work on the model will include adding and configuring new model views (facades, sections, details). In addition, in most cases, it will be necessary to use additional elements such as zones, stairs, and components such as furniture and equipment.

When creating a model, you should take into account the need for several specialists to work simultaneously, as Revit is a BIM system designed for collaborative work.

During the creation of a physical model of a building, its analytical model is also created - a simplified three-dimensional representation of the engineering and design description of the physical model of the load-bearing structures. The analytical model contains load-bearing elements, geometry, material properties and loads that form the building system. This data can be used to link the design with analysis and calculation programs for structural design. With the Advance Steel Extension for Revit, BIM data can be exchanged between Autodesk Revit and Autodesk Advance Steel, including elements such as steel beams, plates, timber and reinforced concrete elements, grids, and connection elements.

Autodesk Revit provides tools for designing engineering systems for DOE buildings, such as air duct systems with mechanical air circulation, heating, cooling, electrical systems, and pipelines. It can be used in conjunction with other Autodesk products to create more coordinated models.





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# Physical and architectural models of reconstruction of an industrial building in Chernivtsi

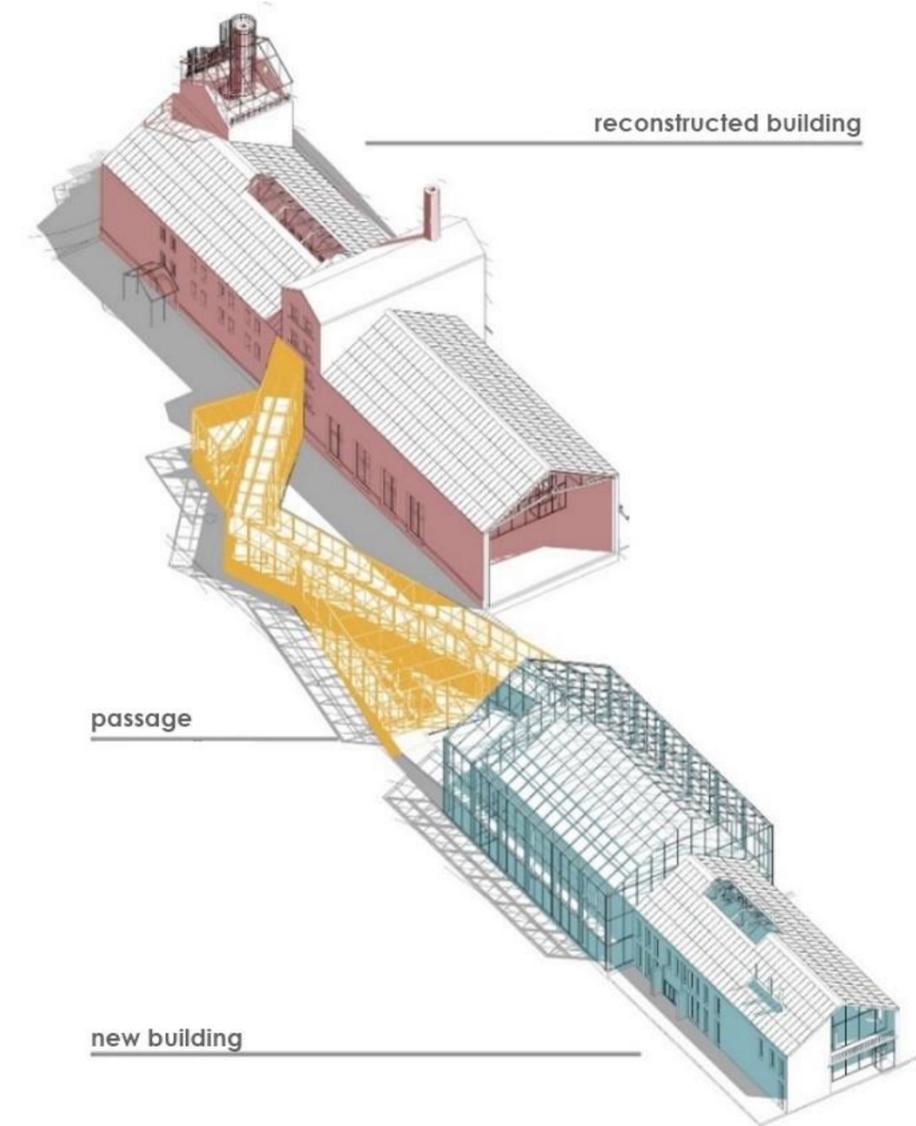
The task in organising the reconstruction of this area was to create an environment that would combine and revive the surrounding existing buildings and be perceived as a single whole.

The main idea was to fit the new building into the silhouette of the old industrial neighbourhood, the chimney and the factory facade, which are present on the site.

The complex itself consists of two blocks, one historical and one modern, which contain two halls, united by a pavilion, which is a system of ramps.

The ramp runs from the reconstructed building to the projected building and from the projected building leads to the winter garden. The projected complex can be used multifunctionally.

For example, for large-scale conferences, presentations, and exhibitions, it is also a place for walking, with open areas with landscaping. There is also a brewery museum, which stretches over 5-floors and leads to an observation deck where visitors can enjoy the views of the city of Chernivtsi.



Reconstruction project





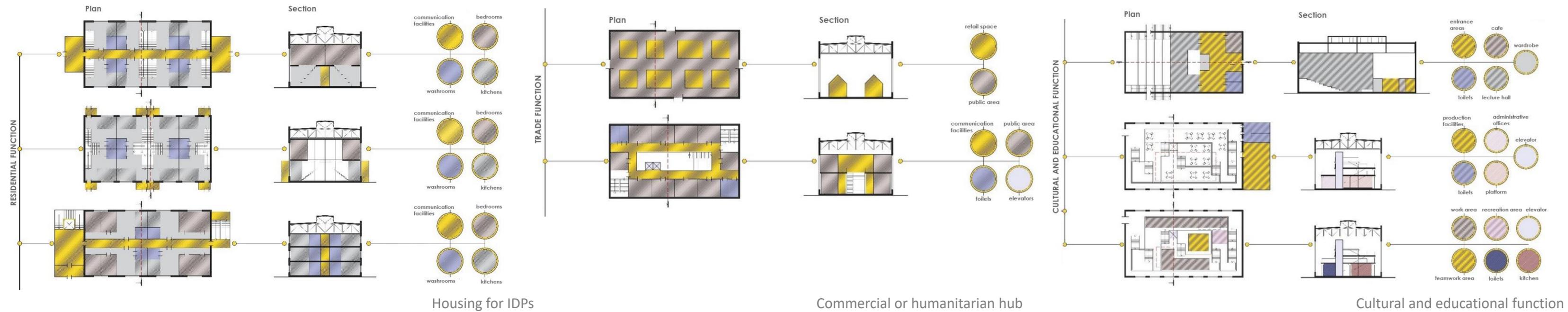
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Taking into account the current situation in Ukraine, such a project could have the following functions: housing for IDPs, commercial or humanitarian hub; employment centre with production and coworking, or have cultural and educational function.





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In general, the reconstruction of a brewery is a more environmentally friendly option for redeveloping territories than demolition and construction.

It helps to reduce the cost of reconstructing an industrial building, create the status of a cultural monument, attract additional investment in the project due to the "historical" object included in the complex, and preserve urban planning dominants.

Currently, this industrial area, which has a good location near the city centre, should be allocated for commercial facilities, office centres, residential real estate and the development of the necessary infrastructure.



Final rendering





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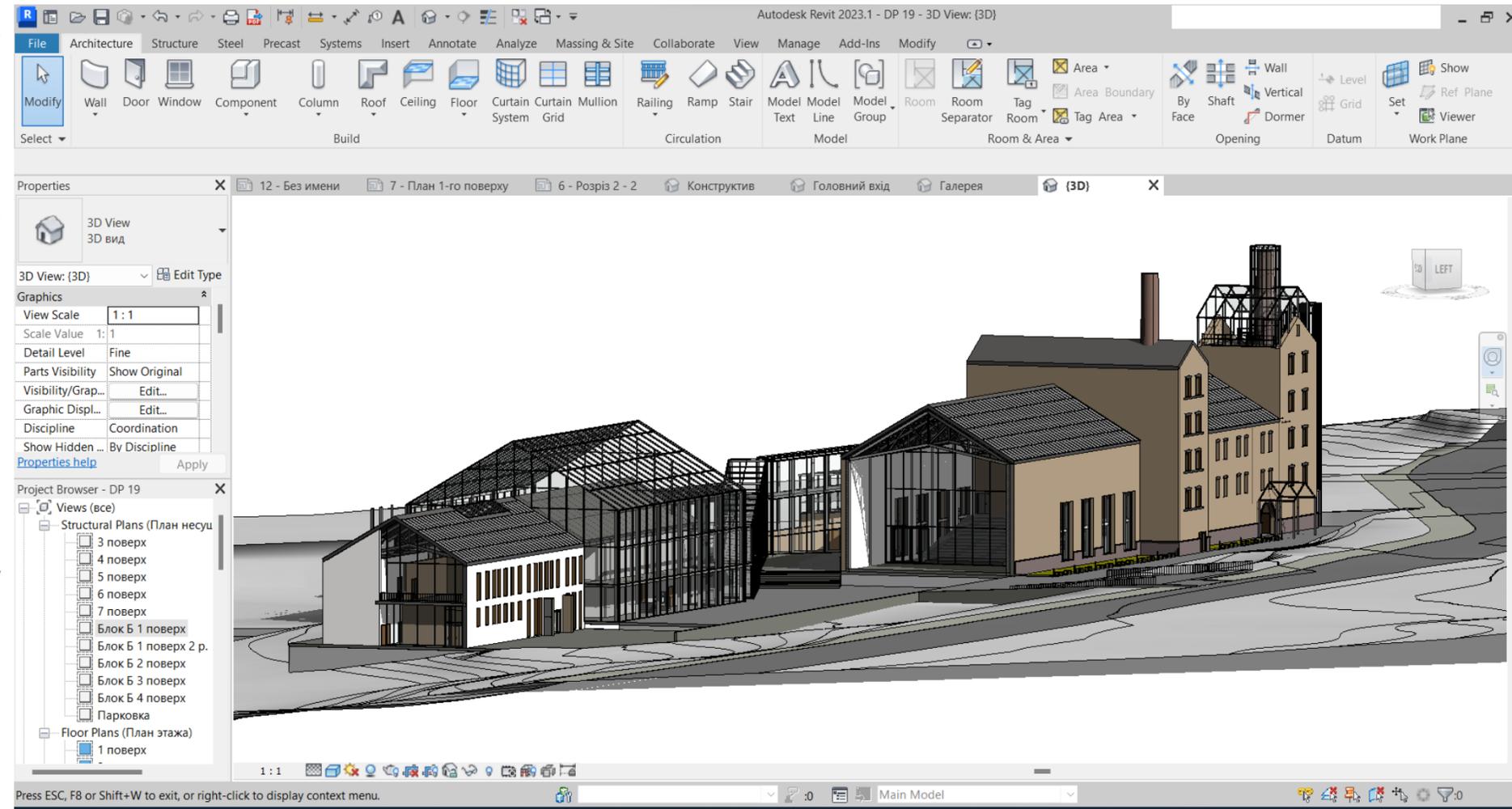


# Concept for the reconstruction of an industrial building using Autodesk Revit

These guidelines are aimed at learning Autodesk Revit at the level that allows to build a 3D model of a building and create basic architectural and construction drawings – plans, facades, sections.

These guidelines can be used as supplementary documentation for practical training on following topics:

1. Description of the programme. Installation, interface, methods of work.
2. Setting up plan levels. Creating a grid of axes.
3. Description of walls, their characteristics.
4. Description of windows and doors, their properties. Create and configure types/styles.
5. Description of stairs and handrails, their properties. Custom shapes.
6. Description of floors and roofs. Building and editing.
7. Create a facade and section, flat and three-dimensional. Setting up the perspective view of the camera.
8. Visualisation – styles, materials and light sources.
9. Create and design Sheets. Transfer of Views (plans, facades, sections, 3D views) to sheets.
10. Create and configure text types and sizes.



The program interface is largely similar to standard Autodesk programs such as AutoCAD, Inventor, 3D MAX.





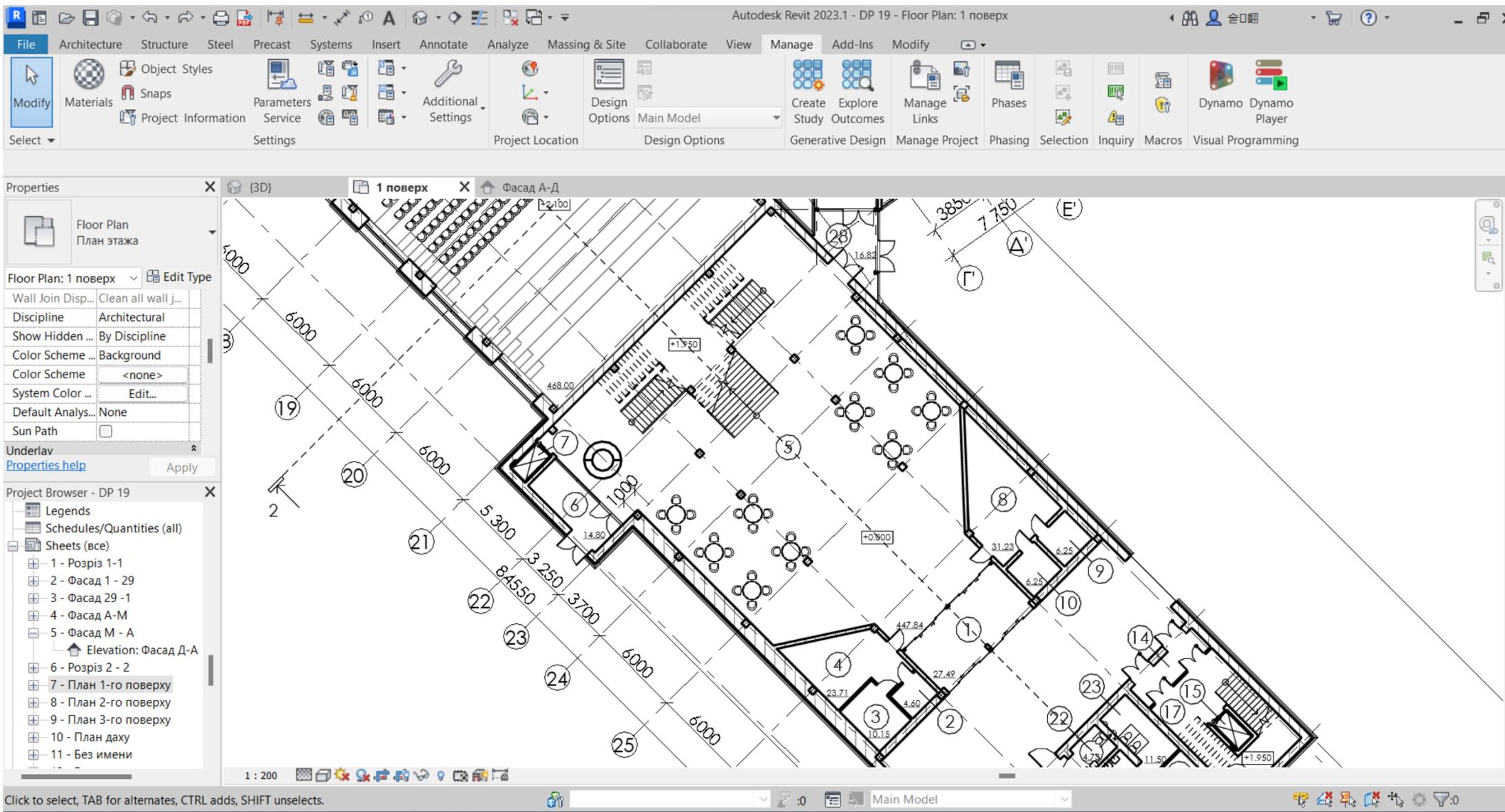
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Part of the ground floor plan with specification

	The «Wall - Partition/Bearing» command. Allows using standard drawing commands to build straight or curved wall segments.
	Command Column. «Supporting» or «Architectural».
	«Architectural» is the default «rectangular section column». Always inserted vertically. The insertion point is specified.
	«Supporting». The column can be either vertical or inclined. «Vertical» columns can be automatically arranged according to the intersection points of the centrelines. When inserting an «Inclined» column, the start and end points are specified (in the plan view), and in the «Parameters panel» – the plan «levels» and offsets from them.
	Columns, like walls, can use the Join/Disconnect Top/Base commands.
	Beam commands. Beams can be automatically built/placed along axis grid lines (if there are columns previously placed along the same grid). Unlike «columns» and «struts», the shape of a «beam» can be defined not only as a rectilinear segment, but also as an arc or spline curve.
	Scatter commands. When the command is activated in the «Parameter bar», the levels of the start and end anchorages and their offsets are specified.
	The «Truss» command allows to insert into the model structure in the form of a truss. If necessary, the shape of the upper/lower belt and the structure of the internal connections can be quickly changed.
	The «Beam system» command allows to build a structure in the form of parallel beams inside a given contour.





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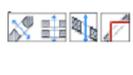
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The screenshot displays the Autodesk Revit 2023.1 interface. The main window shows a facade elevation drawing of a building with various levels and structural elements. The interface includes a ribbon with tabs for Architecture, Structure, Steel, Precast, Systems, Insert, Annotate, Analyze, Massing & Site, Collaborate, View, Manage, Add-Ins, and Modify. The Properties panel on the left shows settings for the selected facade, including View Scale (1:200), Scale Value (1:200), Display Model (Normal), Detail Level (Fine), and Parts Visibility (Show Original). The Project Browser on the left shows a hierarchy of views, including 3D views, Galleries, and Elevations (Фасад здания), with 'Фасад 1-14' selected. The status bar at the bottom indicates 'Model Groups: Model Group : Група масива 1' and 'Main Model'.

-  «Door/Window» commands. In the «Properties» window, select the family and type describing the shape and dimensions, specify «bottom bar height». Use tracking dimensions for exact placement when inserting/editing. Use the control arrows to specify the outside of the wall for the selected object. For doors, also specify the hinge side/opening direction (clockwise or anti-clockwise).
-  The «In wall» command. By default, only the rectangular shape of the 'opening' can be set in the wall. In «Properties» sets «Base dependence» (floor plan level), «height», offset «bottom» or «top».
-  The commands «Edge», «Shaft», «Vertical» allow to build apertures in floor, ceiling or roof slabs.
-  Cut command. The cut line is drawn on the plan view. If the cut line does not cross the structure (passes outside), the resulting view is similar to the facade.
-  Facade command. Builds an additional facade marker on the plan view. Creates a new view in the «Project Manager» in the «Facades» section.

Levels on the Facades tab





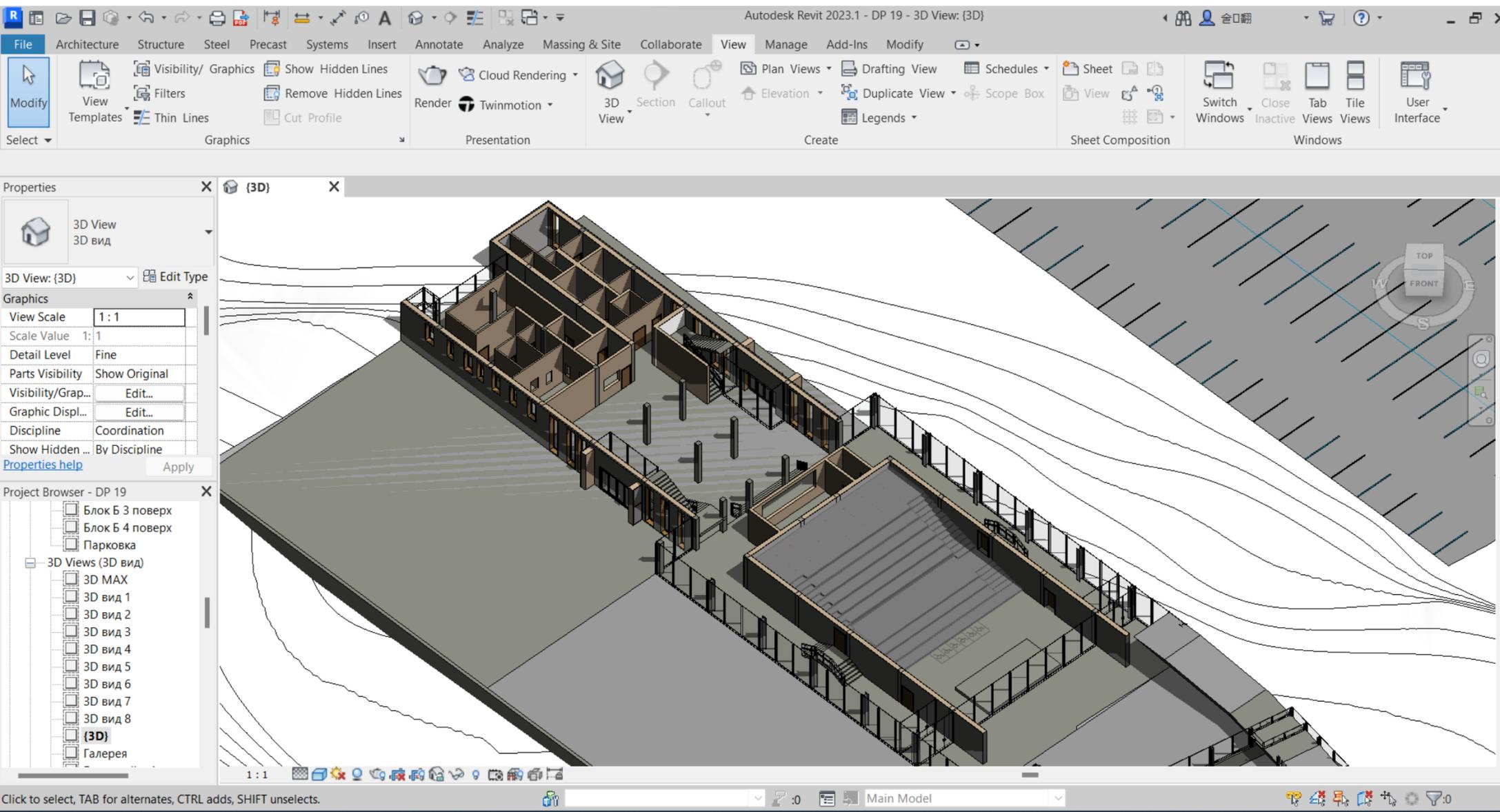
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3D section in Revit

	Staircase command. When building stairs in the «Parameters panel» specifies «anchoring» (centre or edge) and «current width of the rung». In the «Properties» window the stair height (lower and upper «level», offsets) and the number of steps are set. The dimensions of the stair structures, stair height restrictions are set in the description of the type/style.
	The main component of the staircase is the «Span». The shape of the span can be «Straight», «Spiral», etc.
	Additional component «Ramp». Used in multi-span staircases.





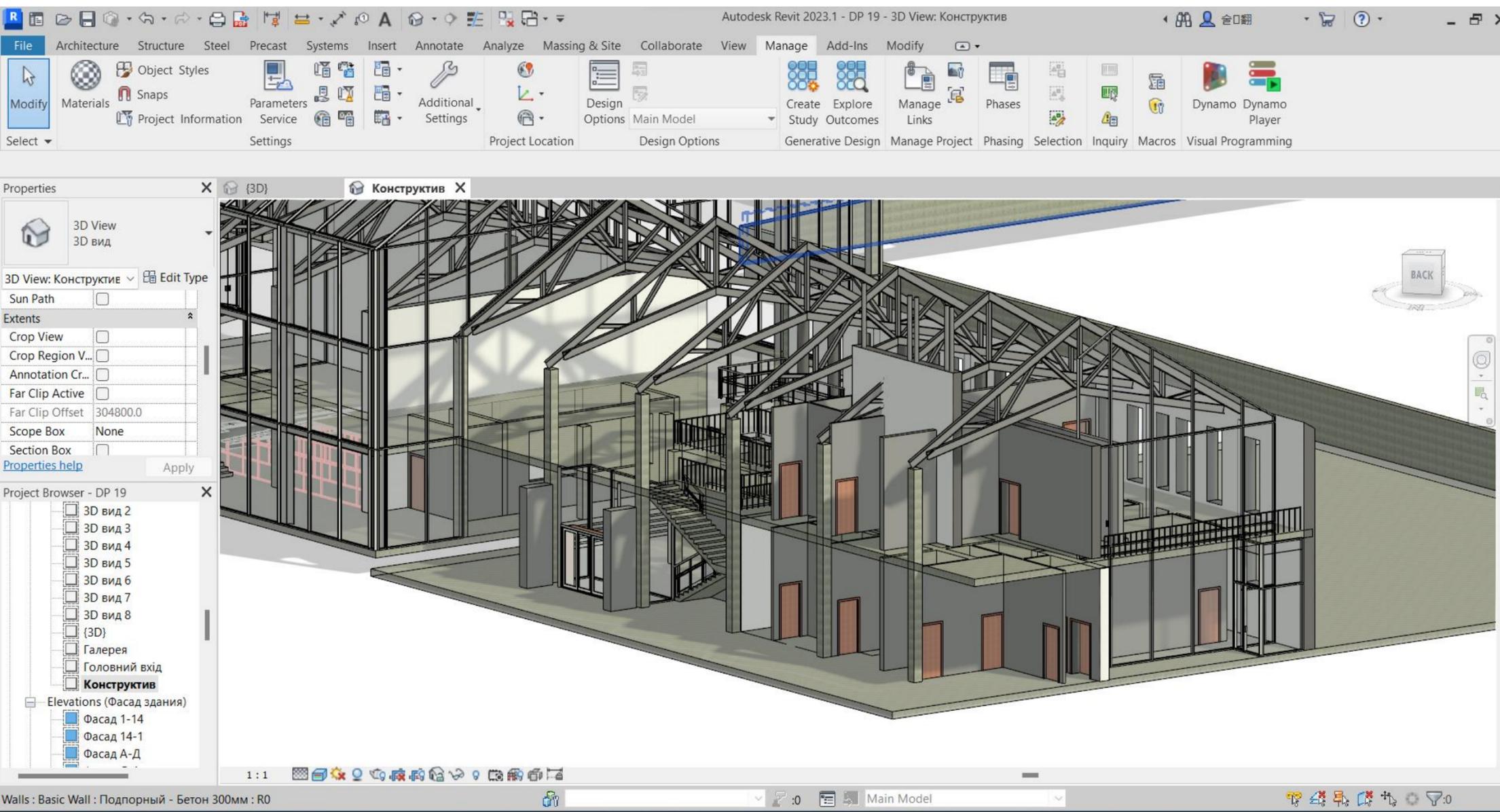
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	The command «Overlap: architectural/substantial». The floor sketch is built on the plan view. In the «Properties» of the floor/ceiling overlap slabs can specify type, plan level and offset from it.
	«Ceiling» command. The ceiling is displayed in «ceiling plans» and 3D views.
	A slope line/arrow can be specified for floor/ceiling slabs for the entire surface.

	Roof contour command. It is used in roofs with a constant slope. The thickness of the slope is postponed from the specified level upwards.
	The extrude roof command. It is mainly used for modelling slopes with variable slopes.
	The roof by edge command. Allows to build roof slope along the edge of the forming element.

Design of structural elements





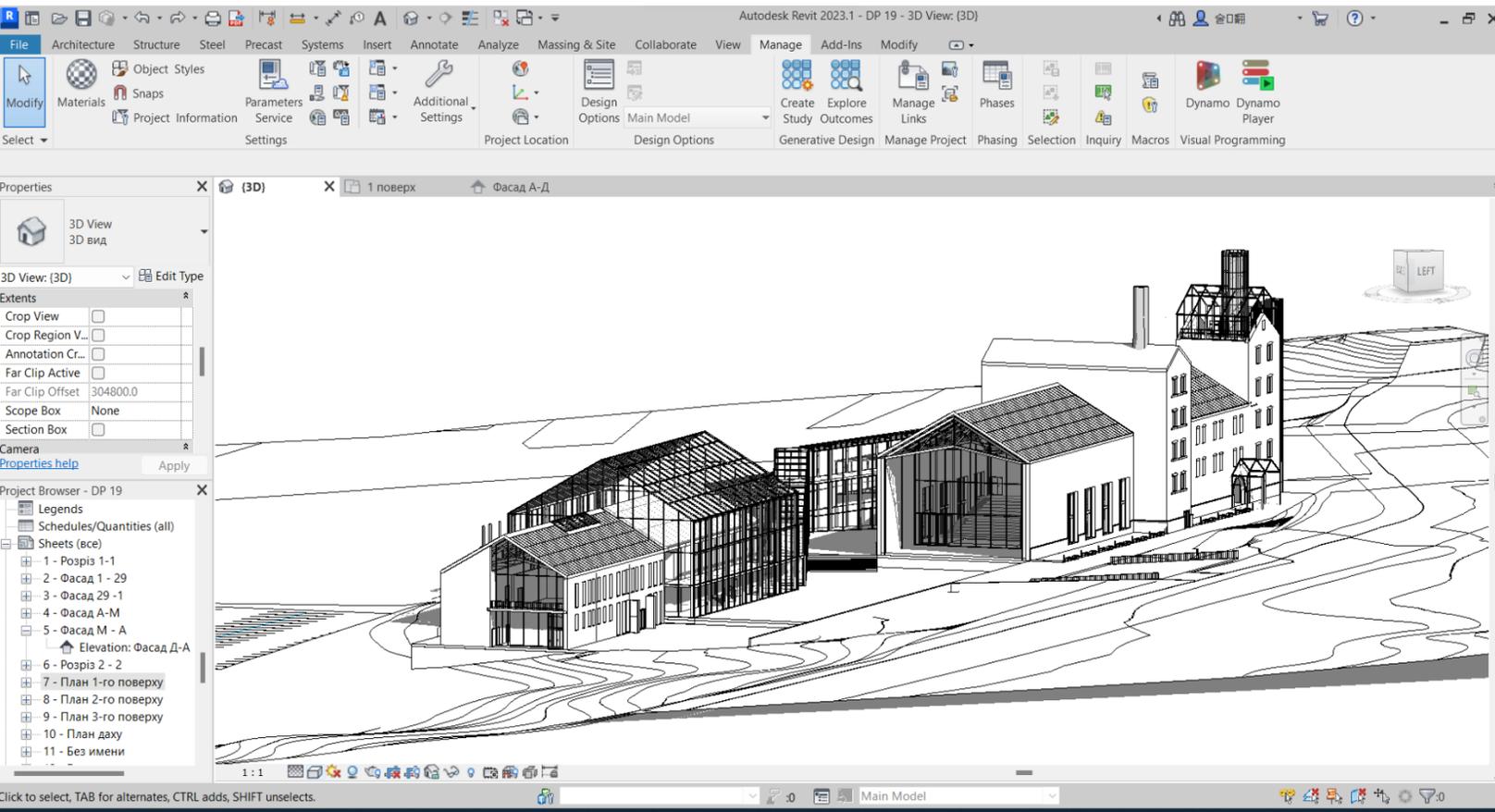
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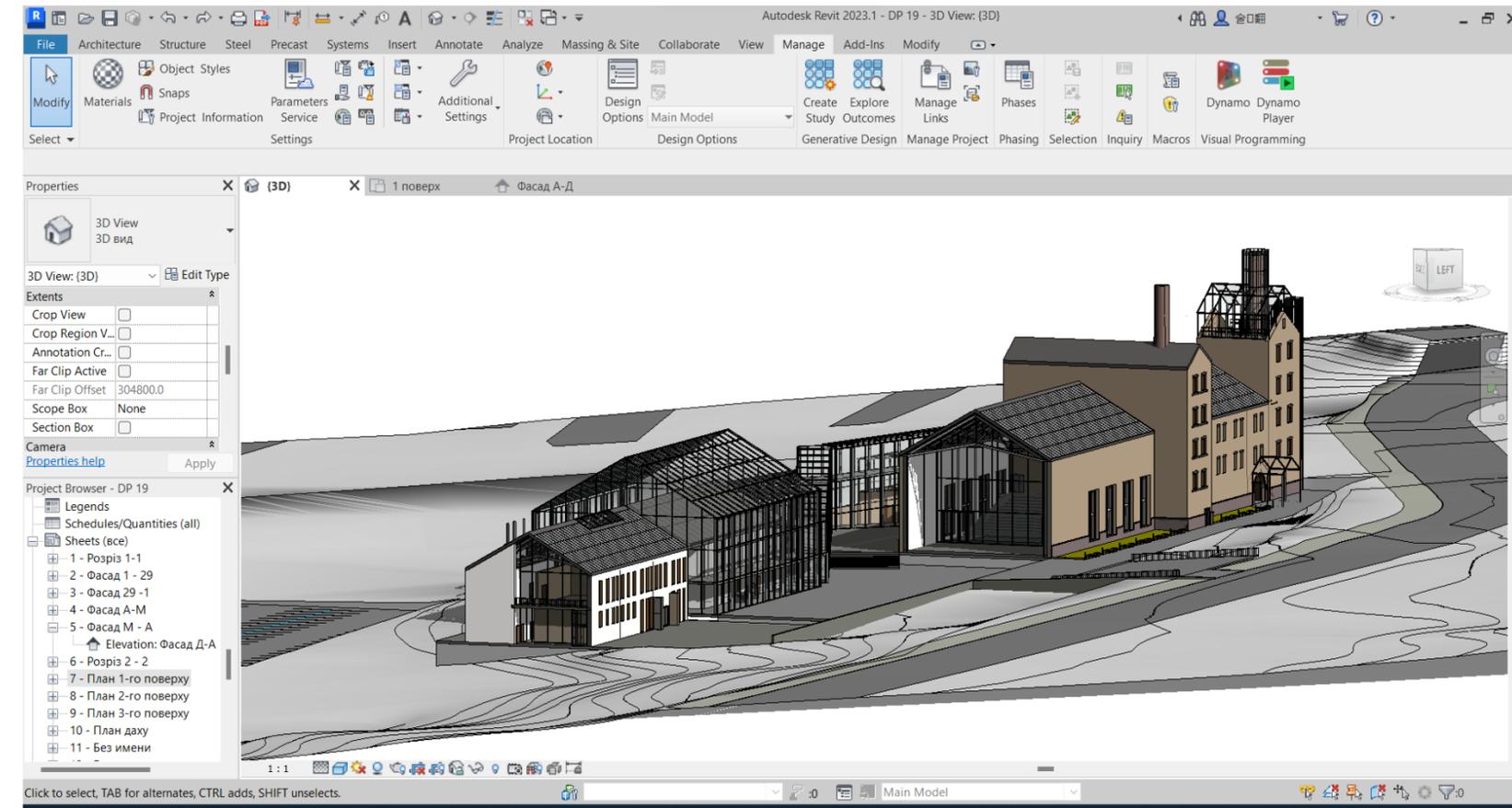
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Hidden line style



3D view





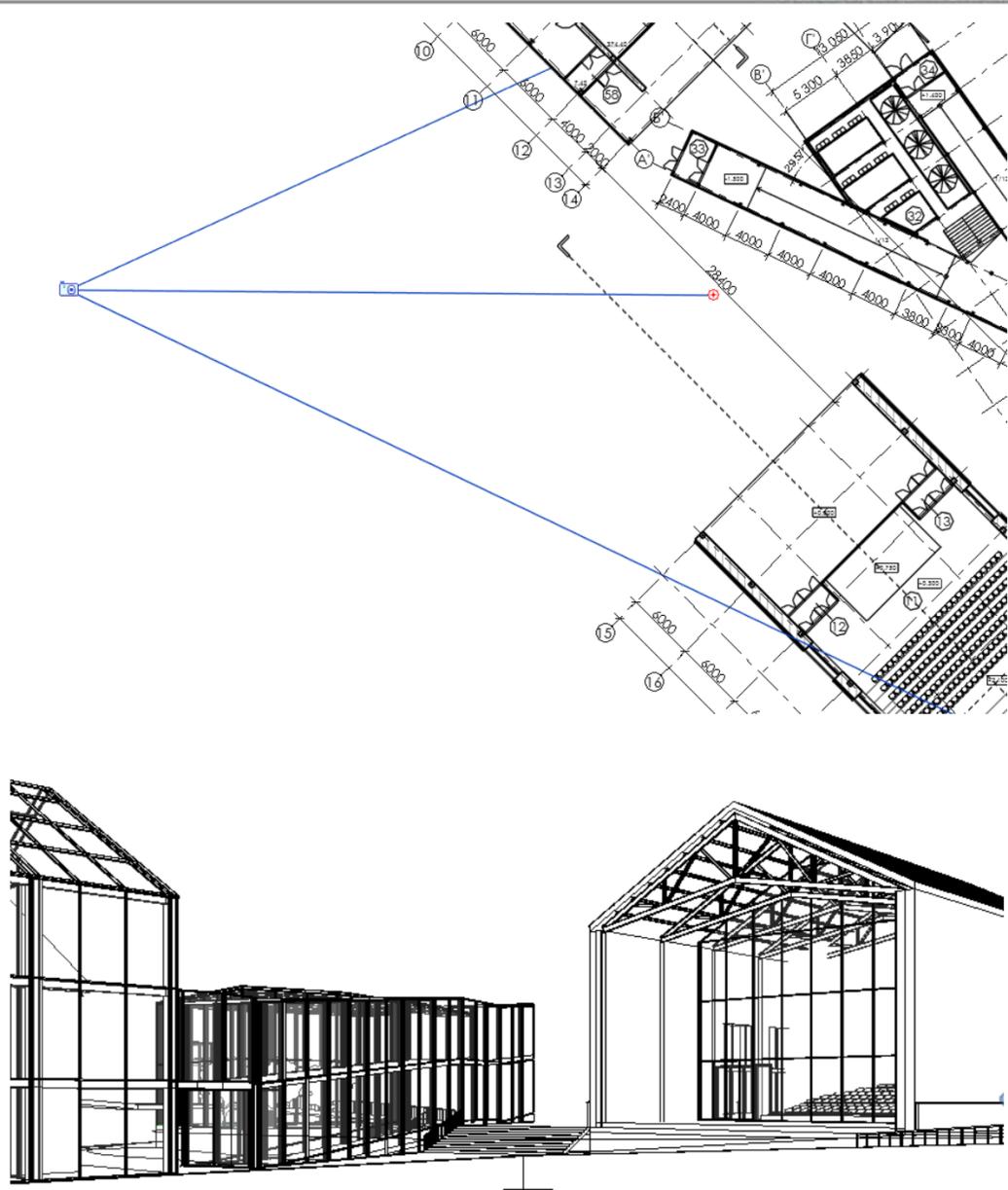
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The screenshot shows the Autodesk Revit 2023.1 interface. The main window displays a 3D perspective view of a building facade. The 'Rendering' panel on the left is open, showing settings for Quality (High), Output Settings (Screen resolution, 872x654 pixels), Lighting (Exterior: Sun only), and Background (Sky: No Clouds). A 'Rendering Progress' dialog box is open on the right, showing a progress bar at 22%. The dialog also lists missing texture files:

- 21\_white bricks texture-seamless.jpg
- TexturesCom\_BricksSmallOld0037\_1\_seamless\_S.jpg
- grass\_grass\_0048\_02\_preview.jpg
- TexturesCom\_BrickMessy0200\_1\_seamless\_S.jpg

At the bottom of the dialog, there is a checkbox for 'Close dialog when rendering is complete' and a 'Stop' button.

The rendering process in Autodesk Revit



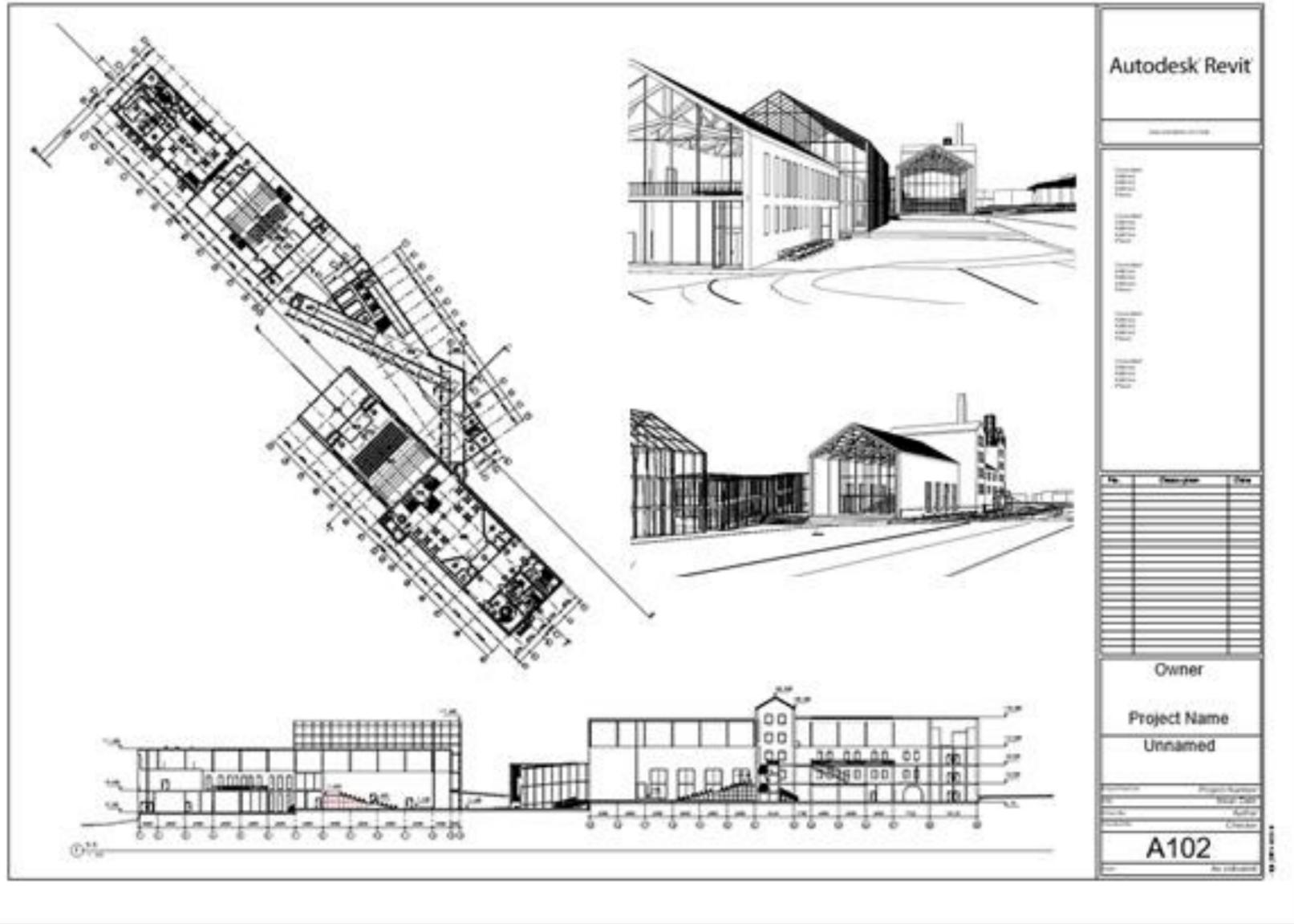
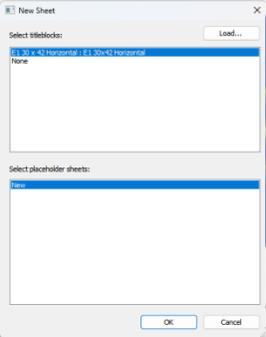
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The «Sheet» command (View tab, Sheet Composition panel) or the «New sheet...» command.

Completed architecture sheet





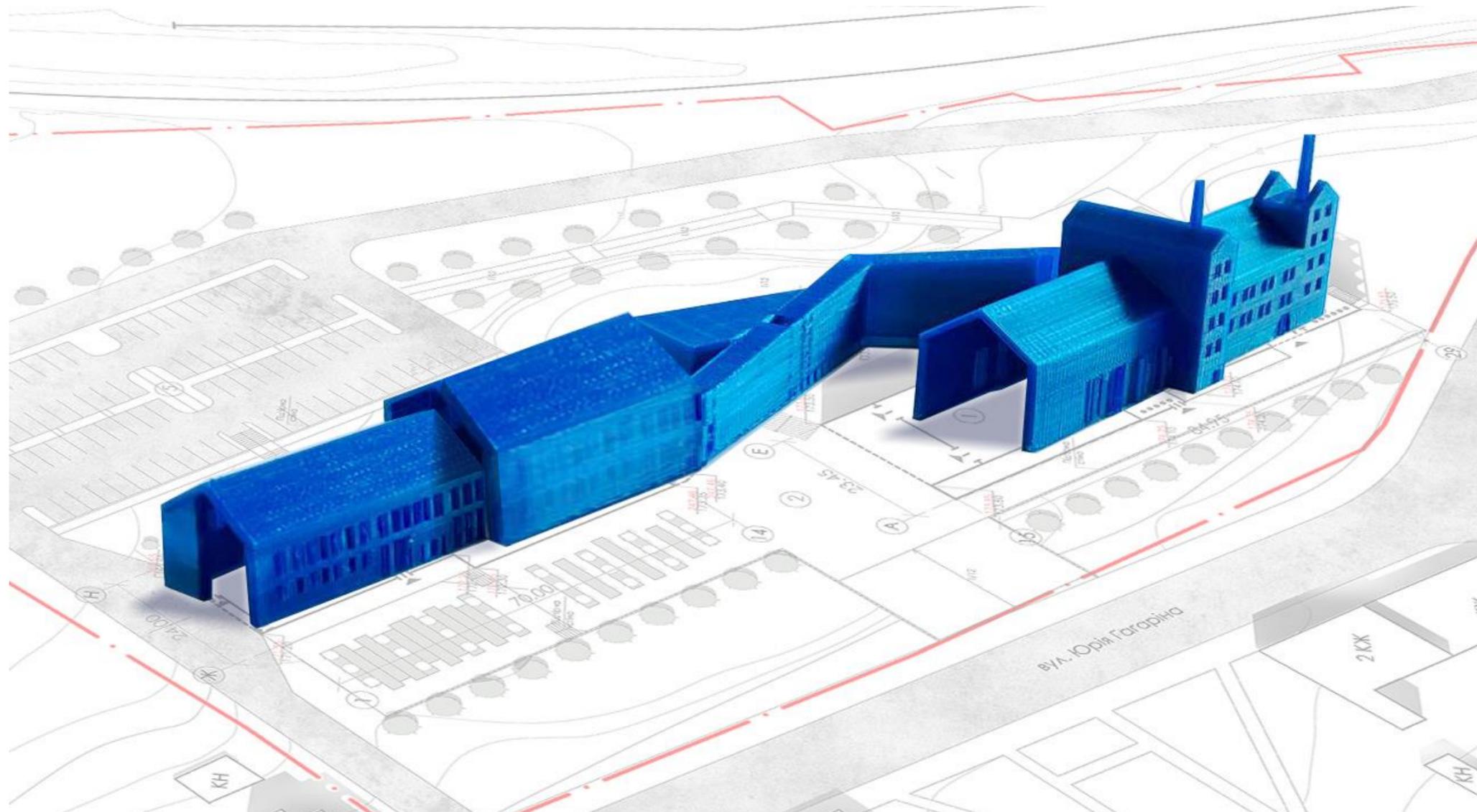
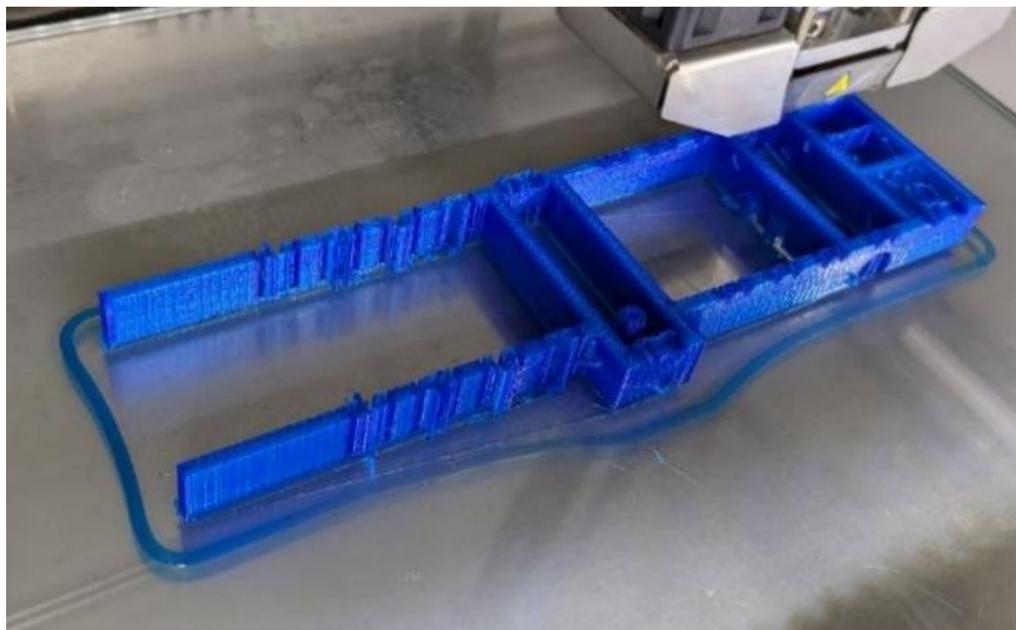
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Finished 3D model





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**GRACIAS !**

**ДЯКУЮ !**

