

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

**O. M. BEKETOV NATIONAL UNIVERSITY
of URBAN ECONOMY in KHARKIV**

METHODOLOGICAL GUIDELINES

for practical and independent work
on the discipline

**“ARCHITECTURAL DESIGN:
MAQUETTE OF INDIVIDUAL RESIDENTIAL BUILDING”**

*(for second-year full-time foreigner students first (bachelor's) level of
higher education specialty 191 – Architecture and town planning)*



**Kharkiv
O. M. Beketov NUUE
2021**

Methodological guidelines for practical and independent work on the discipline “Architectural design: Maquette of individual residential building” (for second-year full-time foreigner students first (bachelor's) level of higher education specialty 191 – Architecture and town planning) / O. M. Beketov National University of Urban Economy in Kharkiv ; com. : M. Liubchenko, O. Smirnova, A. Radchenko. – Kharkiv : O. M. Beketov NUUE, 2021. – 38 p.

Compilers: PhD in Engineering science, As. prof. M. Liubchenko,
PhD in Architecture, As. prof. O. Smirnova,
Senior Lecturer A. Radchenko

Reviewer

M. Votinov, PhD in Architecture, docent, head of the Department of Fundamentals of architectural design of O. M. Beketov National University of Urban Economy in Kharkiv

Recommended by the department of fundamentals of architectural design, record № 5 on 17.11.2020.

In the methodical guidelines use materials and images of the maquette of an individual house, developed within discipline of 2nd year gr. A 2019-1 V. Yu. Kosse. There are also examples of performed models of individual housing of 2nd year students gr. A 2018-1, A 2018-3, A 2019-1, A 2019-2, which are located in the exhibition of architectural and art workshops “ARHOUSE” and Engineering and computer graphics.

CONTENTS

Introduction.....	4
1 Historical pre-conditions of forming of modelling as a separate industry in architecture.....	6
2 Theoretical and practical researches of modelling methods.....	7
3 The main types and methods of modern modelling. The basic requirements produced to modern architectural scale model.....	9
4 Types of modern architectural maquettes and their classification. Virtual models.....	10
5 Perspective tendencies of 3D design and virtual modelling. Main programs for 3D design and virtual modelling.....	13
6 Leading technologies instead of traditional methods of modelling.....	16
7 Advantages and disadvantages of 3d design and creation of virtual models.....	16
8 Virtual modelling with further printing using 3d printer: sequence of recreation of modern model using such programs as arhicad and cura.....	18
9 Selection of materials and sequence of work during recreation of the bases of maquette by traditional method of modelling.....	26
References.....	36

INTRODUCTION

The methodological guidelines provide the material necessary to perform practical tasks and tasks for independent work of students in the study of the discipline “Architectural design: Maquette of individual residential building”.

In the methodical guidelines the theoretical information on designing of café is considered, regularities of their formation are considered, the typological characteristic is resulted, and features of formation of an art image of it are considered.

From ancient times, a miniature image of architectural projects of buildings and structures was used to test architectural and structural solutions, finding the perfect and most aesthetic appearance and flawless structure of the intended structure. At the same time, one of the key functions of the scale model was to demonstrate the future object. Confirmation of this has come down to us: models of houses and temples was found in excavations of ancient Egypt and Mesopotamia in the X–V centuries BC. The widespread use of models in ancient Greece, to assess the architectural and structural parameters of buildings indicate the testimony of Aristotle and Archimedes (IV–II centuries BC).

Time passes quickly, the development of humanity continues: we are growing and at the same time, our needs are growing with us. The constant is that architecture always remains an integral part of people. In our every movement, movement through the city or travel, architectural structures play a significant, we can say a decisive role, because everything that surrounds us is the solution of the main problems and tasks that modern man poses to his environment.

“Benefit, strength, beauty” are the aphorism of the ancient Roman architect Vitruvius, in my opinion, perfectly reflects the basic criteria for modern architectural structures. However, given the parameters of our present, we can add “speed” and “economy” of reproduction of any architectural design. It can be achieved by introducing innovative methods of creating an architectural environment.

Modern architects have increasingly begun to replace traditional design methods with more modern and comfortable to use. Now the drawing is done with special architectural programs, simultaneously with the drawing reproduces the appearance of buildings and structures, much of the work on certain calculations and markings in the drawing by car. Scale model has also undergone some changes: the provided part of the work can now be performed virtually, and you can work in real time without all the accompanying manipulations of image output in architectural language is “rendering”.

As mentioned in previous sentences, the needs of mankind are growing every day, and the time to reproduce such ideas is not increasing that is why much attention is paid to search engines that allow to invent innovative methods, in our case, 3D modeling and virtual architectural design. In turn, help to solve the following tasks:

- evaluate and adjust the compositional and functional solutions, the proportions of the construction object, the orientation of the building area and the originality of the design idea at the design stage;
- find out the features of the landscape and understand the scope of future construction;
- to find out the depth of the architectural design, all the advantages and disadvantages of the reproduced project and to correct certain errors at the stage of design decisions;
- to invent the most profitable architectural and constructive solutions of a certain object from different sides.

The decision to explore this topic is due to the fact that nowadays the production of models is undergoing major changes, the need for professional execution of architectural models of customers, designers and designers of apartments, houses, cottages, architectural complexes and landscapes, museums, exhibitions and presentations has increased sharply. In this regard, the demand for high-precision and high-quality models is constantly growing and the problem of training future architects in modern methods of architectural scale model is especially acute. The decision to study this topic is also due to the fact that this issue is poorly

studied and it provides insufficient amount of special literature for architects and designers on the topic of scale model.

In connection with the emergence of new tasks to be solved in the modern model, there is a need to review the manufacturing technology and sequence of work on the implementation of scale models, their properties, as well as reduce, mechanize and optimize the production process of architectural scale model.

1 HISTORICAL PRE-CONDITIONS OF FORMING OF MODELLING AS A SEPARATE INDUSTRY IN ARCHITECTURE

From ancient times, as noted in the introduction, maquette accompanied the architectural work. Models were made in ancient Greece and during the Renaissance to present projects in the field of architecture. Professional carpenters, sculptors, and carpenters were engaged in the production of models.

The architectural scale model has a long history. For sacred reasons, the ancient Egyptians placed in the tombs of miniatures of houses and temples. In ancient Greece, the sacred gave way to earthly practicality with the help of wax and wooden models, the Greeks assessed the quality of the project and demonstrated new solutions in the field of architecture. During the Renaissance, a huge model of St. Peter's Cathedral, more than seven meters long and impressive in its detail, was created. Most experts claim that in ancient Egypt, Assyria and ancient Greece, architects did not use drawings, but models, because they gave a much better understanding of the object than flat images-drawings.

The word “maquette” comes from the French “maquette” and from the Italian “macchietta” and means a spatial image of something, usually in reduced size.

Trypillia models of residential and religious buildings are considered to be one of the oldest surviving models. Discovered in excavations on the territory of Ukraine, they date from the VI–III millennium BC. The above models conveyed the appearance of the building with its vertical pillars or smooth painted walls, sometimes depicting the interior of the house with a stove, benches and even the interior of the room: furniture and equipment.

During the work on the design of any individual architectural building or structure, mass building or complex of buildings and structures, an important place is occupied by the process of making a model of the object.

A maquette is an exact copy of an object that has a reduced scale, which is executed with the necessary preservation of proportions and accurately reflects all the features of the object.

The main task of the scale model is to present the visual appearance of any architectural structure on a highly artistic and aesthetic level. Making models is a very complex process that requires absolute accuracy and a very detailed study of all the characteristics of the structure, which will be performed in the future model.

Both then and today, the scale models reflect the latest ideas concerning the implementation of something new and unusual; thanks to the three-dimensional details, it is possible to visually consider certain proposals, understand how perfect they are, whether they need additional changes and whether they will meet certain needs. Thanks to such part of the project as the maquette of the designed structure, it is often possible to prevent certain errors and correct them at the stage of design and survey work.

Therefore, the need to create architectural models begins when architecture and construction in general and both in the early stages of civilization and today is very important, because it solves many problems in creating any building.

2 THEORETICAL AND PRACTICAL RESEARCHES OF MODELLING METHODS

Modeling, as a method, has the following functions:

- study, experiment, search for the most successful architectural and planning solution;
- demonstration, presentation, display of the result of the creative process.

Since the Renaissance, scale model has been firmly part of the architect's tools. Leon Battista Alberti in “Ten Books on Architecture” said that the architect does not have enough drawings and drawings, and should also use three-dimensional models.

The tasks of modern prototyping, as an independent profession, mainly investment, are designed to demonstrate the project to potential investors, as well as to exhibit at exhibition projects. It should be noted that this way of interaction between the architect and the investor was formed at the dawn of capitalist relations, during the Renaissance, when trade and financial elites, who are the main customers of public and major private buildings, preferred to have a clear idea of things they invest money.

Currently, there are three main methods of reproducing any architectural object in the maquette:

1. The classical method, i.e. manually (using improvised materials and tools, such as paper, cardboard, fiberboard, polystyrene, adhesives for various purposes, stationery and others).

2. Combining computer and manual method (a successful combination of two methods is used; modeling of the maquette is done with the help of special programs, they immediately reproduce all the necessary textures and calculations, translate to the required scale, build scans, print them, and assemble and glue all the obtained details in the traditional way).

3. The most innovative to date – the creation of a virtual model with special programs with the ability to further print on a 3D printer.

The latter method is becoming increasingly popular due to the relative simplicity and accuracy of architectural models, which is why this method is the subject of this research.

In addition to this information, it should be noted that until recently, all models were made mainly of wood, cardboard, paper and plaster by hand. Recently, completely new in their interpretation of architectural compositions are created using polymeric materials such as organic glass, celluloid, cellophane, foam and a variety of plastics (both white and multicolored for printing on 3D printers), which have a significant advantage over with wood, cardboard, paper and plaster. Polymeric materials are not exposed to atmospheric influences, are easily processed and glued

both among themselves, and with other materials. Not surprisingly, they are widely used in the manufacture of a variety of models and, in particular, architectural.

3 THE MAIN TYPES AND METHODS OF MODERN MODELLING. THE BASIC REQUIREMENTS PRODUCED TO MODERN ARCHITECTURAL SCALE MODEL

Modern architectural models have a large list of certain requirements and criteria that must be met, because without them, today, the model will lose its relevance and feasibility.

Therefore, the main properties that must be endowed with a modern scale model are:

1. Realistic reproduction of both the building and the environment. This is probably the most important criterion, because a realistic scale model always attracts the most attention and focuses a lot of views around it and most importantly - the desire to reproduce the design solution, reflected in a realistic maquette. This technique is achieved through the accuracy of reproduction of objects, the use of various realistic textures and materials, as well as the illumination of the architectural structure, which adds a certain emphasis and draws attention to the forms of the architectural object.

2. Resistance to possible mechanical damage during transportation and operation of the model. This technique can be achieved by using high-strength materials, strengthening the corners of the maquette, the appropriate use and the correct selection of tools and instruments, thanks to which this requirement will be met.

3. Maximum simplification and acceleration of reproduction of architectural models, easy access to the materials used and tools used for work.

Since, as mentioned earlier, architects are increasingly turning to non-traditional scale model methods and use such innovative techniques as 3D modeling and creating a virtual model with the possibility of further printing.

4. Maximum optimization and mechanization of reproduction of the architectural model and the environment.

5. Minimization of space for storage of the architectural model.

Such techniques can be adapted for virtual models, because such new technologies in the form of a special range of computer programs help not only to reduce the time to perform such models, but also to minimize storage space of the virtual model (only 1,5 × 4 cm media, simply put - a regular flash drive).

It will be possible to demonstrate such scale models in real time, despite the fact that the person who is currently working on the scale model is thousands of kilometers away from the customer. Even 10–20 years ago, this would probably seem unreal. Now all this is becoming our reality with you, which we can easily reproduce and change at will.

4 TYPES OF MODERN ARCHITECTURAL SCALE MODELS AND THEIR CLASSIFICATION. VIRTUAL MODELS

Maquette is the creation of a volume that represents space in three dimensions. The scale model always gives an idea of one of the methods of three-dimensional expression of the architectural idea, combining orthogonal projections: facades and plans.

All scale models can be divided into architectural and technical. It is clear that for the manufacture of both, the model needs certain knowledge and skills. In the first case it is elementary knowledge in the field of architecture, in the second case elementary knowledge of technics, mechanisms is required. Maquettes can be divided into types.

Depending on the scale and purpose the maquettes can be:

Architectural. These are models of civil public and private buildings. These can be models of individual houses, cottages, as well as neighborhoods, neighborhoods. As a rule, they are made with detailed filling (road markings, small architectural forms, landscaping, parking, etc.).

Urban planning. Planning models that give a general idea of planning a large area, part of the city, the territory of a large plant. Such maquettes give a general idea of the location of large significant objects in a particular area.

Industrial. Models showing the infrastructure of industrial enterprises, plants, mills, factories. They can reflect both a complex of buildings and a separate part, such as a separate site, shop and so on.

Conceptual. Such maquettes should reflect the very idea, the concept of filling the space, areas in a single style, and plan. Detailing on such models recedes into the background; the main thing is the demonstration of the idea itself. Similarly, these scale models should reflect how the new filling of the space with architectural elements would harmonize with the environment, with existing buildings and objects. The task of such a scale model is to beautifully present and reveal the idea.

Technical. These are models of machines, mechanisms, any equipment. Such models demonstrate not only the appearance of the mechanism, but also the principle of action, the interaction of several parts. There are technical models of the stand. This is a complete external, large-scale copy of any type of equipment, mechanism. Carefully and meticulously made technical scale models often become gift maquettes.

Gift. As a rule, these are maquettes intended as a gift to any person or organization. They reflect a memorable event, expressed in a specific object or in an abstract but easily recognizable structure. Most often, it is a model of equipment (airplane, tank, etc.). Although it may be an architectural image, a copy of a monument, building and so on. Gift models are also characterized by the fact that they usually have a protective case, a professionally made stand with a plate (it is usually written the name of the product, its characteristics, greetings, etc.).

Advertising. The maquette more accurately reflects the architectural solutions, color approach. Such a scale model should clearly show the potential customer or customer what the building in which he will live or work will look like. Where are the windows, where is the parking lot for cars, how will the landscaping of the yard or yard. Such models look especially impressive with large-scale illumination (lampposts, decorative lighting on lawns, front door lighting, billboards and stands).

Copies of cars, figures of people and others are placed on such models for clarity.

The above types and types of scale models are conditional, as each model usually combines several of the above features. In addition, the list of scale model types can be extended. There are also the following models: educational, project, test, demonstration (exhibition), maquette schemes, planning, interior, full-scale, manuals, theater and landscape. By their name, you can fully understand why this or that type of maquette is intended. Still scale models happen static, bench, dynamic, with illumination and without. The backlight can be internal (built-in) as well as external. Maquettes can contain moving parts that are especially important for conveying the meaning of the whole object as a whole, or for reviving and giving a special realism.

Virtual models are separate, most innovative and state-of-the-art type of architectural scale models. Features of the created virtual models is that:

- the scale model is reproduced using a special range of programs that are often publicly available and relatively easy to use;
- the scale model, for example, of a separate building, can be reproduced with great accuracy to the smallest details and textures;
- the scale model can be reproduced in a very short period of time (from one week, it all depends on the complexity of the object and its total volume);
- the size of such a scale model can vary from one object with the adjacent territory and landscaping, to an entire neighborhood or even a city;
- scale model does not require real-time storage. it can be stored on any media (phone, computer or standard flash drive)
- the scale model can be “traveled” to look from different sides, go into the room, go from floor to floor, like in a real building;
- the scale model of such a building can be created tens of thousands of kilometers from the customer, and can also be easily “sent” to the other end of the world via e-mail or regular manager and the Internet.

Now, more and more programs are being introduced that do not require additional “interventions” and additions to textures or elements of the environment the simulation takes place in real time.

5 PERSPECTIVE TENDENCIES of 3D DESIGN AND VIRTUAL MODELLING. MAIN PROGRAMS for 3D DESIGN AND VIRTUAL MODELLING

3D modeling is a modern technology of building a three-dimensional model of an object in three-dimensional space on the basis of professional graphic software products. Advanced three-dimensional modeling technologies and professional programs for 3D modeling provide unlimited opportunities to create 3D models of objects of different sizes and levels of complexity, as well as to manufacture and test product prototypes.

3D modeling is a stage that precedes the creation of an architectural virtual model and can be used in:

- making a prototype product;
- development of three-dimensional animation;
- preparing a presentation of a new product;
- testing the functionality and design of a new product;
- creation of outdoor advertising and advertising models;
- reproduction of design packaging of goods, printed products and POS materials;
- with 3D model in architecture and design;
- when designing molds for casting;
- computer games, cinema, etc.

The most famous and professional software products for building and editing three-dimensional models are Blender; Sweet Home 3d; SketchUp Make; Sculptris; LEGO Digital Designer. With these programs, you can create almost any level of complexity 3D-model of the object. In addition, each of them contains highly

specialized tools for three-dimensional modeling. Consider each of them in more detail.

1. Blender. Blender 3D modeling software is a free package for working with three-dimensional graphics. The program includes tools for animation, modeling, rendering, as well as tools for post-processing video and computer game development. Blender features allow both professionals and regular users to work with it; here are all the basic tools and tools, texture sets, event handlers and models of a professional 3D editor.

In addition, it is possible to implement additional features of the program when connecting special plug-ins.

Blender features: support for various geometric shapes; contains built-in mechanisms and tools for rendering and merging with an external YafRay render.

2. Sweet Home 3D. Another free modeling program, most often used when working with interior design. Sweet Home 3D allows you to easily create a plan for a separate room or the whole house, place furniture, windows, doors, stairs, etc. at the discretion of the designer. The program has a special catalog with samples of furniture, for greater user convenience, it is organized into categories. New models of furniture can be downloaded for free from the developer's website.

Features of Sweet Home 3D: convenient and simple interface; availability of furniture samples collected in one catalog; ability to import individual 3D objects or a house plan from the program; possibilities of editing of textures, their import and formatting of furniture accessories; multilingual interface and support for many useful plugins.

3. SketchUp Make. Convenient and fairly simple program for building 3D objects and editing them. This simulation program has almost no windows for pre-settings and this is one of its main advantages. With the built-in Google Earth plug-in, ready-made 3D objects can be hosted on Google Maps. SketchUp Make is the optimal program for beginner 3D modelers and designers, compared to complex counterparts.

The main characteristics of SketchUp Make: simple and user-friendly interface; availability of basic editing tools clear to everyone – eraser, pencil, ruler, protractor, etc., only in three-dimensional space; possibilities of export / import of elements of both raster two-dimensional graphics and three-dimensional graphics - psd, png, jpg, bmp, 3ds, ddf, dwg; availability of a replenished library of styles, components and materials, the possibility of using various plug-ins; shadow installation functions; the ability to download ready-made scripts; merge with Google Earth.

4. Sculptris. A program for 3d modeling, the main advantage of which is the gradual, fast and easy mastery of the skill of creating three-dimensional models. Simplicity of the interface and possibilities of work with the program even without in-depth knowledge in modeling. Contains tools for drawing, extrusion, smoothing of the developed model. The availability of a large number of editing tools and configuration systems allow you to create models of varying complexity in Sculptris.

The main features of the program: storage of the model in OBJ format, which makes it possible to work with this model in another 3D-editor; automatic editing of model symmetry; adjustment of working “brushes” is adjustment of the size, force of pressing and other; the presence of sculptural brushes designed for indentation, drawing, smoothing and twisting, etc. contains a system of masks that protect the area of the model; simulates a large number of different materials used in creating 3D models; gives the opportunity to “paint” the model.

5. LEGO Digital Designer (LDD). Designer designed to build 3D LEGO models. It has a huge selection of different parts, the color of which can be changed in the process. Easy to operate and has a user-friendly interface. Allows you to zoom in and out of the LDD workspace, move freely in space and rotate at any angle. Includes a view of the finished model, where you can change its background.

The main features of LEGO Digital Designer: a wide range of LEGO-elements, more than 700 varieties; storage of ready models; the ability to upload the finished model to the official website of the program; unlimited number of details.

6 LEADING TECHNOLOGIES INSTEAD OF TRADITIONAL METHODS OF MODELLING

Traditional (or classical) model methods today are most often used among students of architectural, design and other creative specialties, as well as for special individual orders in architectural and model workshops.

Less common is the partial use of technical (computer) tools in combination with manual methods of creating models. It should be noted, however, that the use of computer technology significantly speeds up and simplifies the process of reproducing the object model.

With more mass production of models, architects often resort to the most modern methods of modeling and model of the environment through significant simplification and optimization of the process, a significant reduction in time to achieve the desired result and the ability to more realistically reproduce the necessary details of any project.

Of course, it is too early to talk about the complete and radical replacement of traditional methods (or even their partial use) - some possibilities, even the most modern programs are not yet able to reproduce; moreover, when the word "model" itself is mentioned, few people can think that it can be virtual in the literal sense - yet we imagine a reduced copy of a reproduced object by hand from paper or cardboard. In my opinion, it will take a long time for traditional model methods to be completely replaced by virtual innovative technologies.

7 ADVANTAGES AND DISADVANTAGES of 3D DESIGN AND CREATION of VIRTUAL MODELS

In our days, the creation of virtual models of architectural structures is, of course, a big step forward towards a major technological breakthrough in the field of modern architecture.

Based on the above information, we can draw the following conclusions about the benefits of implementing 3D modeling and creating virtual models:

1. Modeling with the possibility of further 3D printing is done using a special range of programs that are publicly available with a relatively simple and clear interface in their use, so to apply modeling and, accordingly, model not only architectural objects, everyone can (this requires just understand how to work with a program).

2. Model of the object can be reproduced with great accuracy to the smallest details and necessary textures.

3. The scale model can be reproduced in a very short period of time (even in a few days the time spent on such a model depends on the complexity of the object and its total volume).

4. The size of the virtual model can vary from a single object with the surrounding area and landscaping, to an entire neighborhood or even a city - it all depends on your technical task or imagination.

5. The virtual model will not require space for real-time archiving. It can be stored on any media (phone, computer or standard flash drive) and viewed at any time.

6. You can easily “travel” with a virtual model. Look from different angles, enter the room, and go from floor to floor, as if in a real building.

7. Ability to further edit the virtual model, make certain changes in color, planning or design decisions.

8. Possibility of further printing of the object as a whole, with landscaping and environment, as well as its individual parts, which must be considered.

9. Virtual model is a 3D model of any object can be created tens of thousands of kilometers from the customer, and can be easily “sent” to the other end of the world via e-mail or a regular manager and the Internet.

10. During the simulation itself, you can easily run a demonstration of your screen while working: this way, for example, the customer will be able to observe the process of creating a model in real time.

11. In terms of money costs, virtual model is much cheaper compared to hand-made scale models. Plastic used for further printing is also relatively inexpensive.

12. If you need to print a scale model, use a 3D printer, which is also relatively inexpensive and (if you discuss the scale of production) does not require the retention of a specialist who deals only with scale model.

3D modeling and virtual model have an infinite number of advantages over traditional methods of creating architectural scale models. However, a virtual model or 3D model has only one major drawback: they will never replace the classic scale model of any building, because before such an object can be touched, feel each of its elements completely; such a scale model is undoubtedly unique.

8 VIRTUAL MODELLING WITH FURTHER PRINTING USING 3D PRINTER: SEQUENCE of RECREATION of MODERN MODEL USING SUCH PROGRAMS AS ARHICAD AND CURA

Before the implementation of any architectural scale model, the project itself is performed: the main set of drawings (planning decision) and the appearance of the building (visualization or drawing of the facades of the building and visualization of the building from different angles, enough 2 angles). This approach minimizes errors in subsequent model and significantly reduces its execution time. Typically, the above steps are performed in the ARHICAD program. It is necessary to pay close attention and avoid mistakes when working with the size and scale of the composition of the house as a whole, do not forget about the requirements of anthropometric compliance (the ratio of all designed elements to the proportions of the human body for maximum comfort). In addition, in the program it is very convenient at this stage to reproduce the master plan in 3D – in order to prepare the basis of the model, to be able to fantasize with the elements of landscaping and the overall composition of the general planning of the site. The following is an example of the final stage when working in ARHICAD (Fig. 1–5).

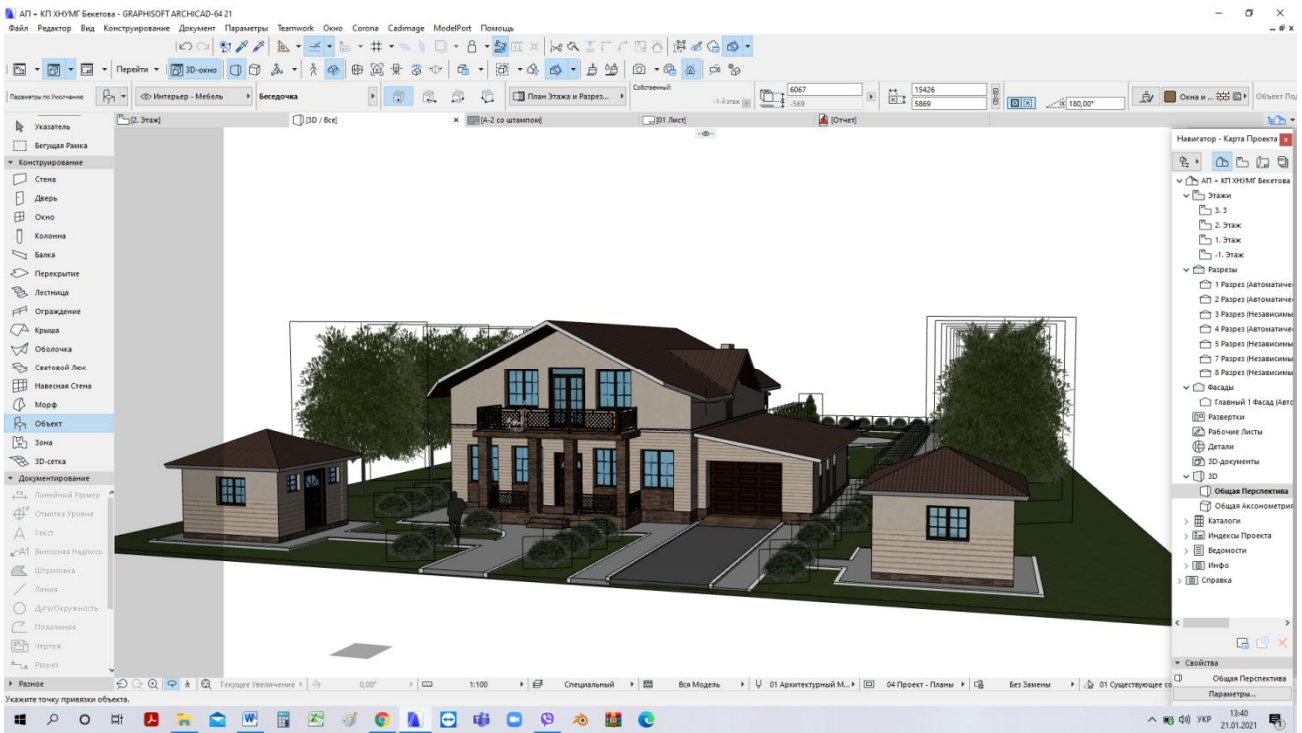


Figure 1 – 3D view of the house and garden area in the program ARHICAD
(the first stage of creating a model for printing on a 3D printer)

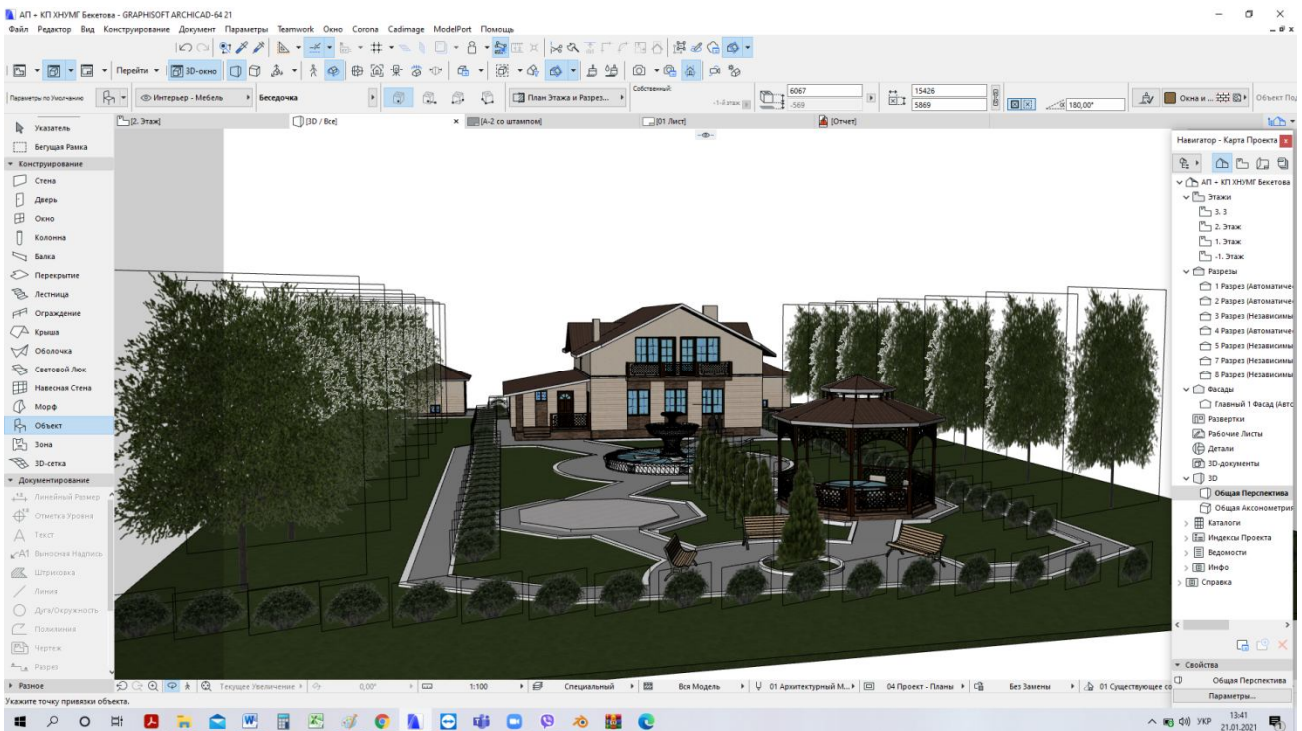


Figure 2 – Stage of work with plans in the ARHICAD program

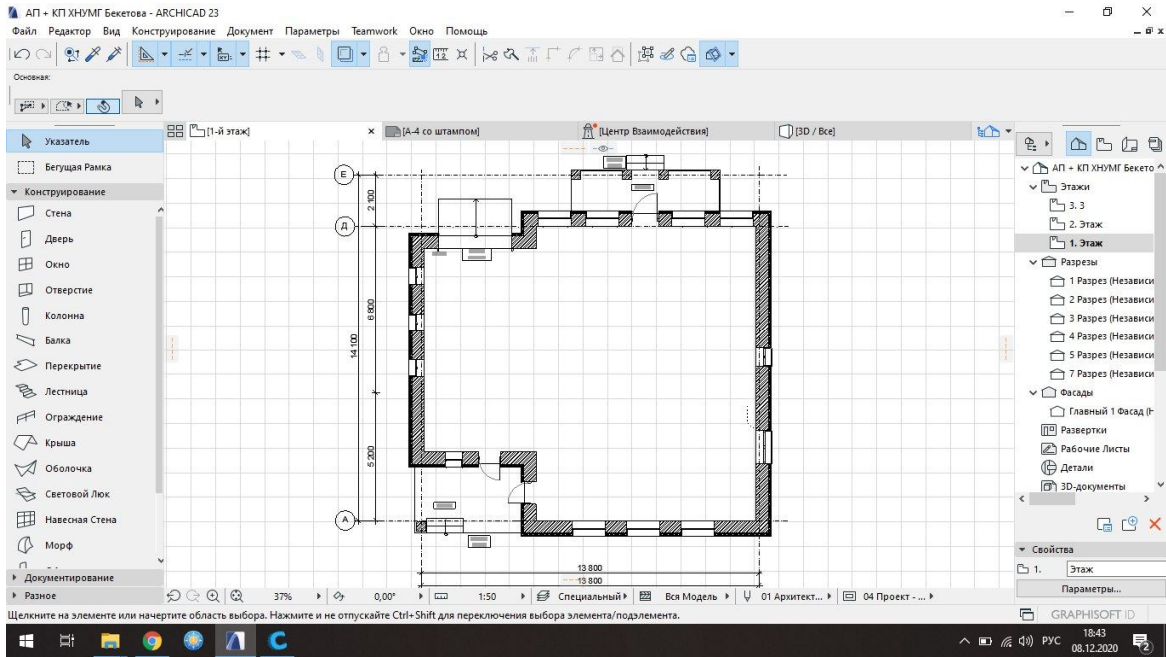


Figure 3 – Stage of work with plans in the ARCHICAD program
(preparing the model for 3D printing)

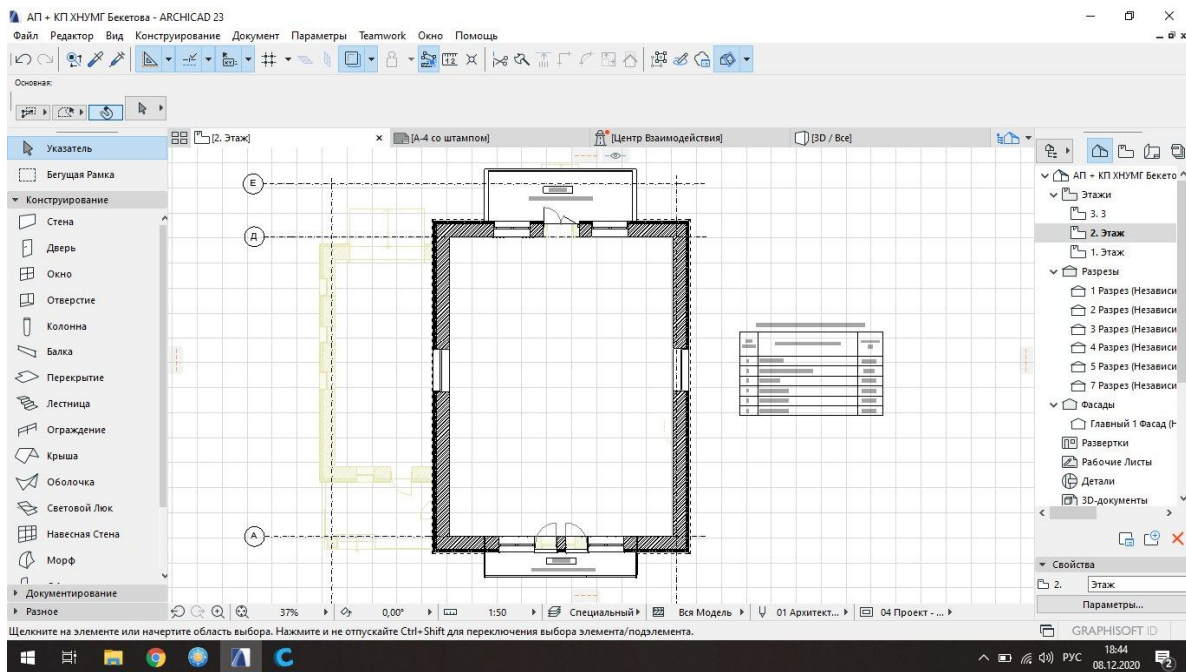


Figure 4 – Remove all unnecessary elements of the model, floors, walls, foundation
(if its presence is not taken into account in the subbase)

After the final verification of all elements of the building and the certainty that the result is correct and final, you can begin the stage of preparing the model for processing in another program, in our case – CURA, which will be printed on the printer. Simply put, it is a linker program for a better understanding of the printer's printing technology.

The plans remove all interiors, walls and partitions, inscriptions and axes of the building, as this will further extend the operation of the printer, as well as the fact that when developing a model at a scale of 1: 100, the interior of the house is not reproduced (Fig. 6, 7).

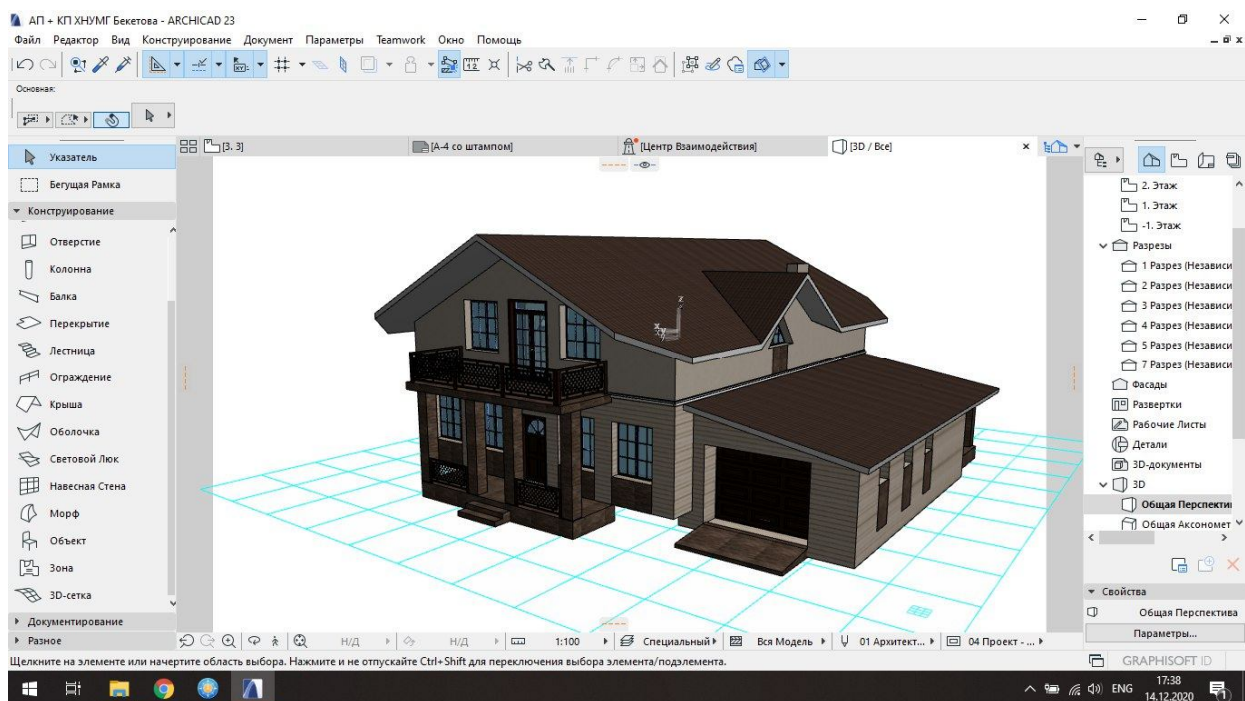


Figure 5 – The next step is to display the walls with all the elements in a single plane to simplify the operation of the printer and not to break up the base and the plane of the walls

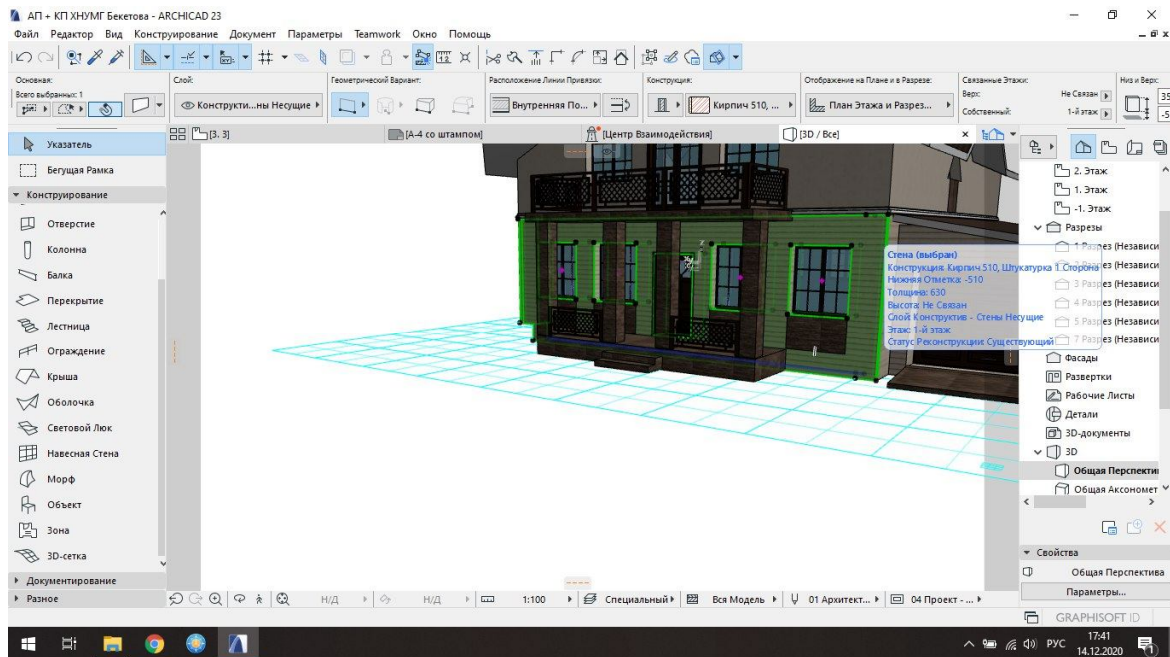


Figure 6 – The stage of the wall with all the elements (displayed in a single plane to simplify the operation of the 3D printer, not shredded plinth and plane of the walls)

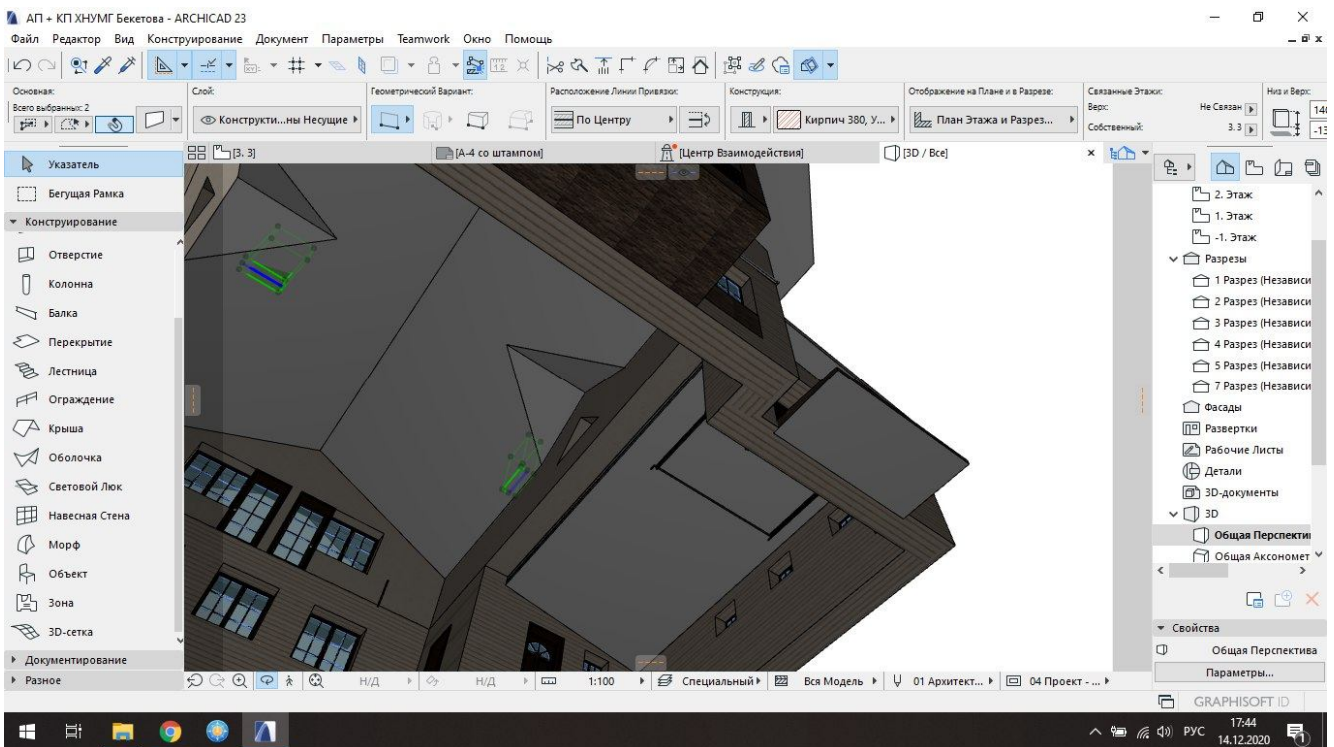


Figure 7 – Check the levels of chimneys to prevent sagging elements in space

This completes the work in the ARHCAD program. Then the following actions take place (Fig. 8–10).

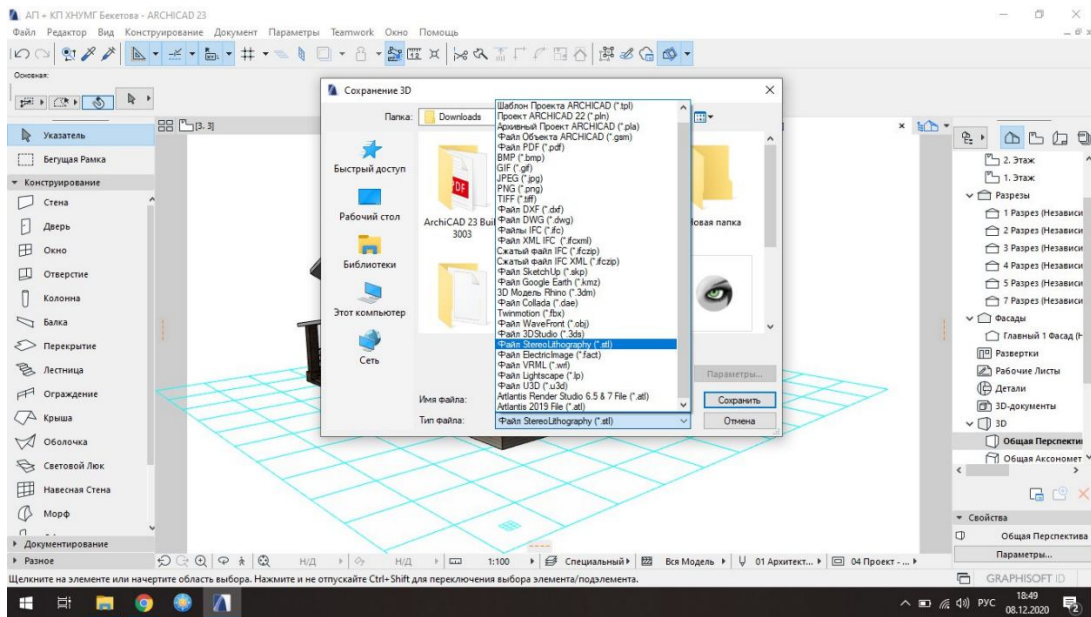


Figure 8 – The ARHCAD file is saved in a format that corresponds to the program for further use. Among the proposed options in this case, choose the STL format

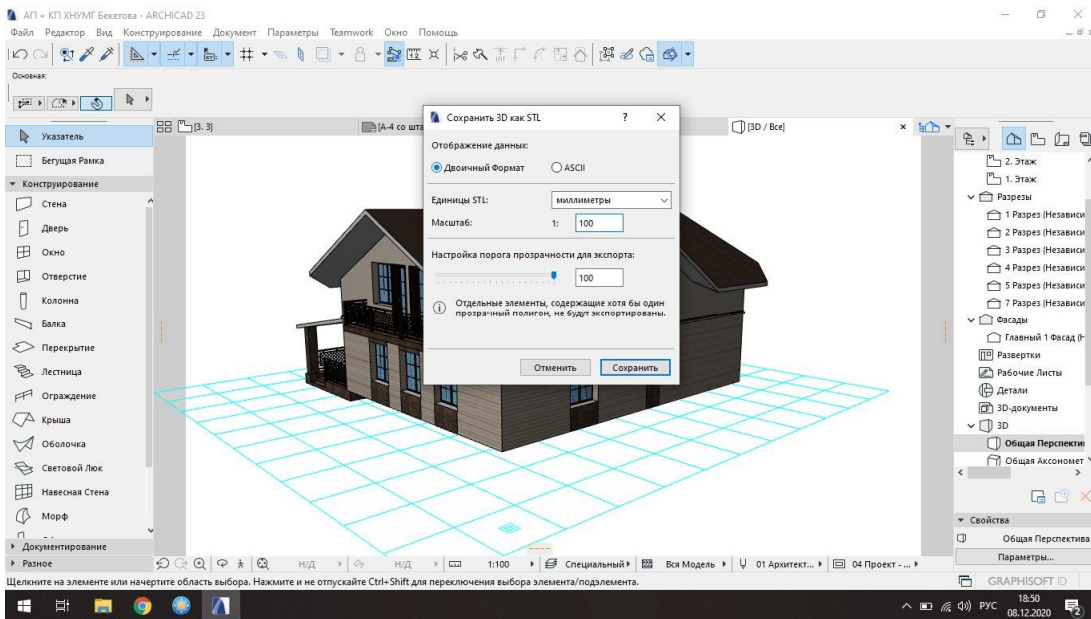


Figure 9– Select the proposed parameters, save the file and open it in the program for printing and further adjustment of CURA

This program will “understand” the previously set parameters in its own way: will reproduce the special strokes of the pen, will show with different colors those areas that will be tightly filled with plastic, which will act as props, and where there will be so-called “free” strokes without the use plastic. The task at this stage is to

minimize the printing time of the printer by adjusting these moves. This program also sets the general parameters of the print area the scale is selected. If the building goes beyond the printing area of the printer, it should be divided into parts, printed separately and then simply glued assembled as a designer (Fig. 10, 11, 12).

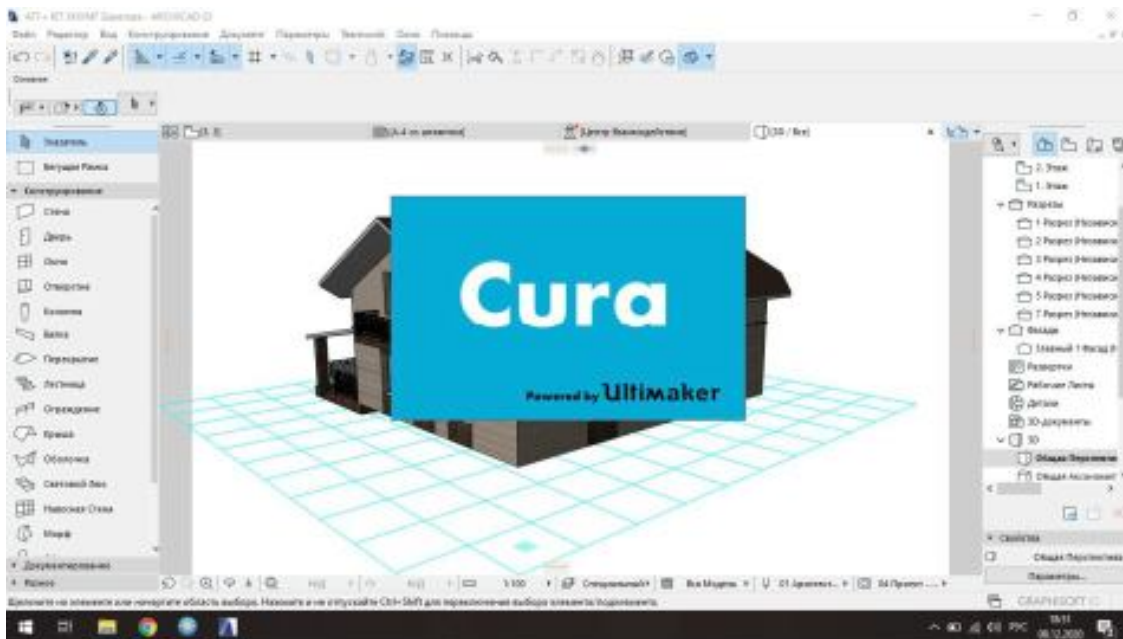


Figure 10 – Opening a saved file in a 3D printing program CURA or FLASHPRINT

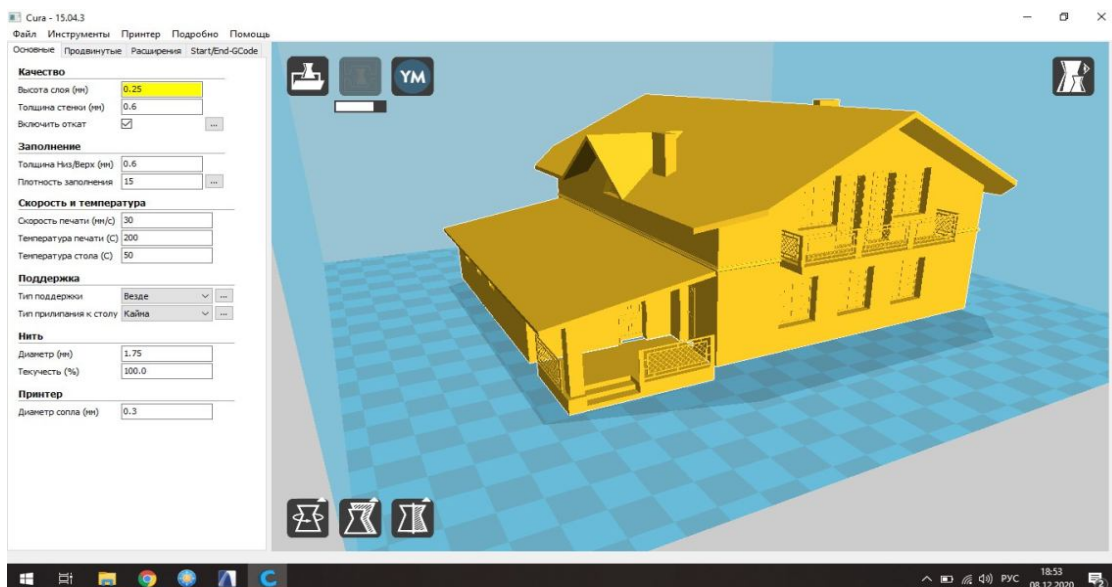
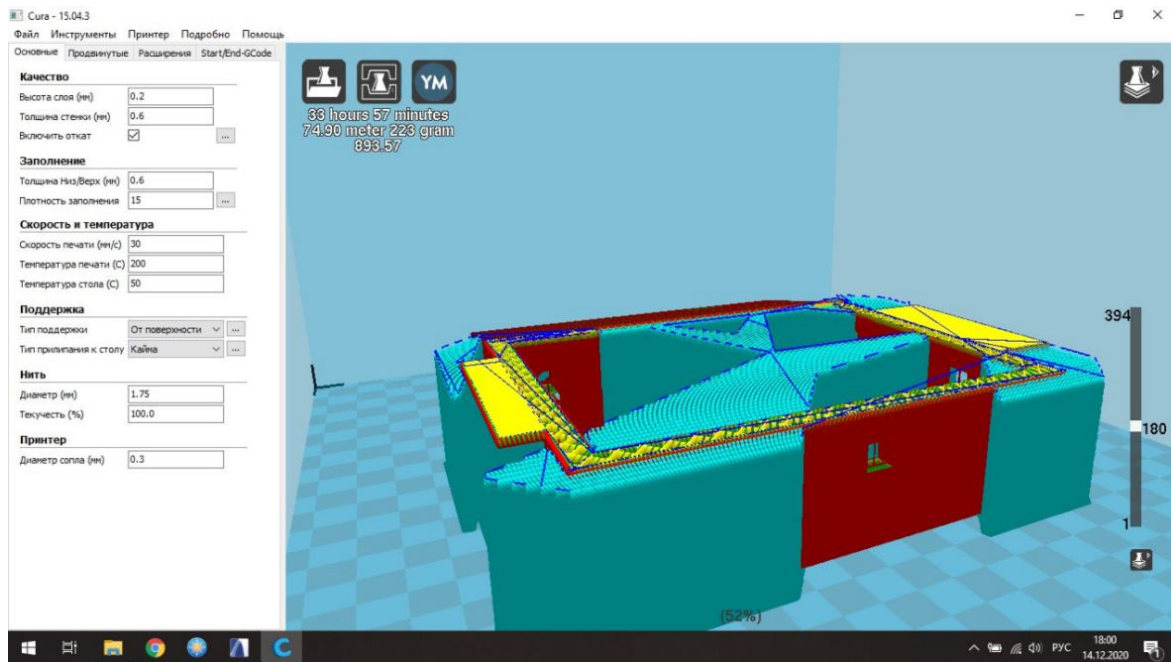


Figure 11 – Printed area on the printer allows you to print the building without separating it



Picture 12 – View on the building under the roof, where you can see which areas will be printed

Blue marked support blue – movement without plastic feed, yellow fill At this stage, the print settings are adjusted according to the model and printer settings, plastic and the features of the model itself. In the case of printing thin-walled parts and overhanging elements (roofs) must be installed support. After adjusting the parameters, the model is converted into a special code and transmitted to the printer and describes the trajectory of the printing pen (dies).

The resulting code is stored on a memory card and launched directly from the printer for printing.

Regarding the materials required for printing: a material such as special plastic is required (see Fig. 13).



Figure 13 – Selected plastic for printing the building

The color range of depleted plastic is quite large, but for printing houses, it is best to choose some light shades (white, beige, light gray, ivory, etc.). You can buy it quite easily in free access. Approximately 250–300 grams of plastic are spent on the average cottage building.

9 SELECTION OF MATERIALS AND SEQUENCE OF WORK DURING RECREATION OF THE BASES OF MAQUETTE BY TRADITIONAL METHOD OF MODELLING

In addition to basic materials, you may also need items such as artificial shrubs, trees) either purchased or made by hand. This will further decorate the created composition and give it maximum realism. You can see examples of creating landscaping elements from simple and inexpensive materials at the link: <https://youtu.be/7FO7y57DM98>.

Auxiliary tools are also required:

- stationery ordinary and circular knives, scissors;
- a special mat for modeling (cuts on it are self-healing, on 2 sides of a rug there is a special marking for simplification of process of cutting);

– glues: office glue-stick, PVA (either ordinary or construction), “Dragon”, “Moment”, hot glue that melts with a thermo-gun or others (based on the materials used);

– double-sided adhesive tape, masking tape, ordinary thin tape (Fig. 14).

The lighting of the house model is very unusual and interesting. When using the maquette backlight, you can use a garland on a thin wire and mini-bulbs that work thanks to the battery-powered unit. This unit is quite easy to attach to the inside of the subframe.



Figure 14 – Examples of materials used to base the maquette

In addition to basic materials, you may also need items such as artificial shrubs, trees) either purchased or made by hand. This will further decorate the created composition and give it maximum realism. You can see examples of creating landscaping elements from simple and inexpensive materials at the link: <https://youtu.be/7FO7y57DM98>

Auxiliary tools are also required:

– stationery ordinary and circular knives, scissors;

- a special mat for modeling (cuts on it are self-healing, on 2 sides of a rug there is a special marking for simplification of process of cutting);
- glues: office glue-stick, PVA (polyvinylacetate use either ordinary or construction), “Dragon”, “Moment”, hot glue that melts with a thermo-gun or others (based on the materials used);
- double-sided adhesive tape, masking tape, ordinary thin tape.

The lighting of the house model is very unusual and interesting. When using the maquette backlight, you can use a garland on a thin wire and mini-bulbs that work thanks to the battery-powered unit. This unit is quite easy to attach to the inside of the subframe (Fig. 15).



Figure 15 – Example of a block with garlands to illuminate the maquette

The sequence of creating a subbase

After all the necessary measurements, selection of the subbase and materials, the creative process of creating the subbase of the maquette begins.

First, on the selected substrate (the figure shows the size of 20×20 mm) using a brush and construction PVA glue (Fig. 16). To prevent soaking and deformation of the paper, it is desirable to put a subframe under the press (load with books or something heavy). After complete drying, you can mark the paths, paving and curbstones. A large-scale fragment of the master plan and a regular stationery will help to do this easily.

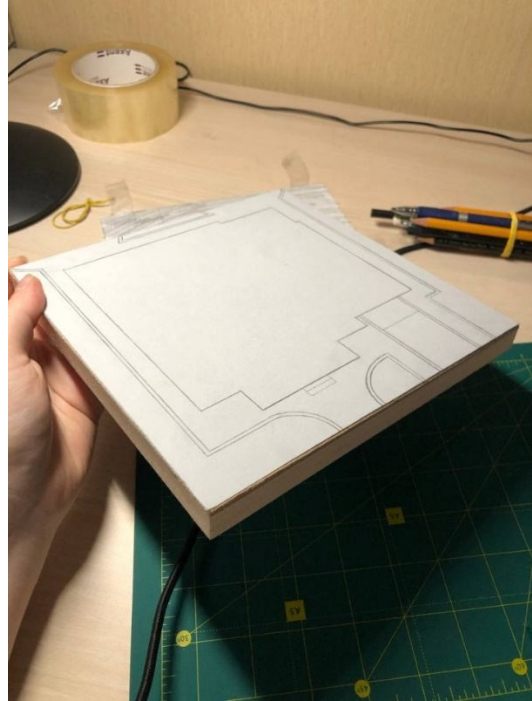


Figure 16 – Subbase after the first stage of preparation



Figure 17 – Subbase after the second stage of preparation

The second stage – marking of textures and performance of imitations of coverings (Fig. 17). If a felt coating is used in the work, it is better to start working with it first. After gluing the felt parts, it is necessary to cut the torsion or watercolor paper into thin strips and stick them on the edges of the lawn. This creates an imitation of the curbstone. Instead of paper, you can also use matches, pre-painted it white.

Next you need to mark the imitations. In this example it is an imitation of paving tiles. In scale, it is marked with a pencil (soft (B) or middle (HB) and to create realistic paving, some tiles are darkened with gray watercolor paint, which gives the tile realism (Fig. 18).



Figure 18 – Creating an imitation (paving tiles)

In order not to obscure the imitation of the tile, it is better to first make a solution of paint with water, and then paint the elements layer by layer. The brush is better to apply, as shown in the photo thin synthetic and elastic.

The next stage is the illumination of the maquette subbase (Fig. 19). First, the pencil marks the marking, based on the number of light bulbs on the garland, it is calculated quite simply. Holes in the submachine gun should be made carefully and attentively. It is better to use a sharp awl or a large thick needle. Light bulbs should not be placed under the walls of the building and under the entrance areas. The holes should be such that the bulbs do not fall out of them. This must be followed very carefully. After obtaining the necessary holes, you need to bring all the bulbs out so that the battery pack and the extra wires remain under the model base. In the future, they can be “sewn” with cardboard, leaving only the glued unit (it should be glued so that if necessary, you can replace the batteries; also in easy access should be a light mode switch).

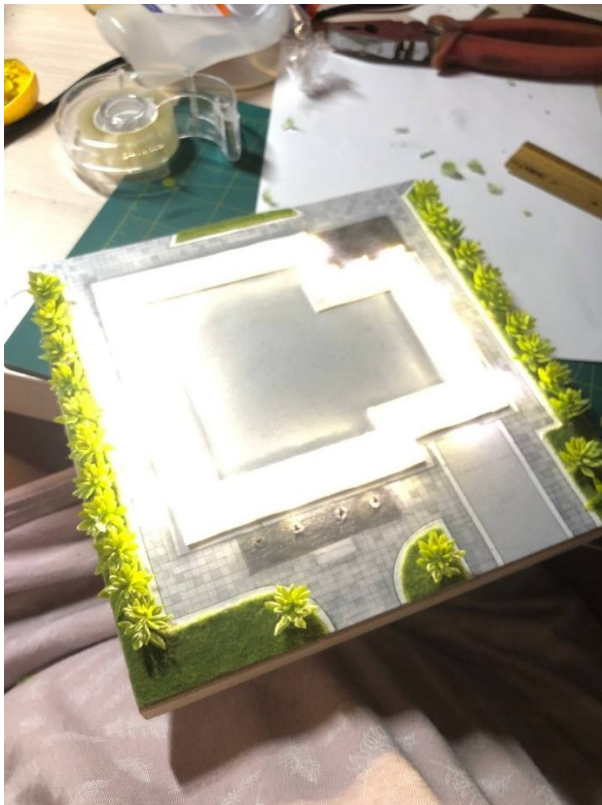


Figure 19 – Prepared foundation before installing the building model

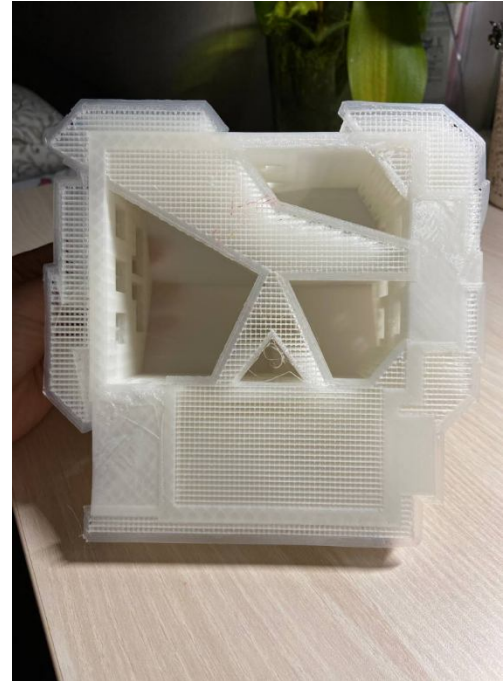
The last no less interesting stage is the improvement around the house. The Figure 19 shows that in this case, ready-made plastic mini-bushes are used. They can be purchased in art workshops, shops with artificial flowers. We must not forget about the scale of the elements used for landscaping and the ratio of colors in the overall composition of the maquette. Stick these elements better thermal glue.

From the received building after the press on the printer it is necessary to peel off carefully all supporting elements. This step must be performed very carefully so as not to break the plastic of the main structure of the building. This step is performed

with an ordinary stationery knife. At difficult cutting of difficult elements the blade can be heated a little over a candle. In this case, the plastic is not cut, but melts, which speeds up the process of cleaning the supports. You can glue the maquette to the subframe with double-sided tape or thermo-glue (Fig. 20).



a



b



c

Figure 20 – Stages of cutting the supports from the obtained building model: a – printed house; b – auxiliary connecting elements; c – cutting of connecting elements

The finished works are shown in the Figures 21–26.



Figure 21 – View of the completed work of the individual residential building maquette, made by a 2nd year student gr. A-2019-1 Kose V.Yu., foreshortening 1



Figure 22 – View of the completed work of the individual residential building maquette, made by a 2nd year student gr. A-2019-1 Kose V.Yu., foreshortening 2



Figure 23 – View of the completed work of the maquette of individual residential building, made by a 2nd year student gr. A-2019-1 Vekshin D. E.



Figure 24 – Examples of solutions for maquettes of individual residential buildings, performed by 2nd year students gr. A 2019-1, A 2019-2



Figure 25 – Examples of maquettes of individual residential buildings, made by 2nd year students gr. A 2018-1, A 2018-3, A 2019-1, A 2019-2



Figure 26 – Examples of solutions for maquettes of individual residential buildings, performed by 2nd year students gr. A 2018-1, A 2018-3, A 2019-1, A 2019-2

REFERENCES

1. Види макетів та їх класифікація [Електронний ресурс]. – Електронні текстові дані. – Режим доступу: <http://globaltao.com/uchebnye-posobiya/vidy-maketov-i-ix-klassifikaciya-osnovy-maketirovaniya-smirnov-v-a.html>, вільний (дата звернення: 25.01.2021). – Назва з екрана.
2. Liubchenko M. Some Aspects of Creating Architectural Scale Models of Buildings [Electronic resource] / M. Liubchenko, A. Radchenko, O. Mandrichenko // European scientific discussions : abstracts of III International Scientific and Practical Conference. – Electronic text data. – Italy, Rome, 2021. – Pp. 285–288. – Regime of access: <https://sci-conf.com.ua/iii-mezhdunarodnaya-nauchno-prakticheskaya-konferentsiya-european-scientific-discussions-1-3-fevralya-2021-goda-rim-italiya-arhiv/>, free resource (date of the application: 10.02.2021). – Header from the screen.
3. Виготовлення та друк 3D макетів і моделей [Електронний ресурс]. – Електронні текстові дані. – Режим доступу: www.architektonix.com, вільний (дата звернення: 25.01.2021). – Назва з екрана.
4. Особливості 3D-моделювання [Електронний ресурс]. – Електронні текстові дані. – Режим доступу: 3d4u.com.ua, вільний (дата звернення: 25.01.2021). – Назва з екрана.
5. Кожуховский А. Н. Применение современных инновационных технологий в процессе изготовления архитектурного макета [Електронний ресурс] / А. Н. Кожуховский // Науковий вісник НЛТУ України, 2013. – Вип. 23.18. – С. 305–311. – Електронні текстові дані. – Режим доступу: http://nbuv.gov.ua/UJRN/nvnltu_2013_23.18_50, вільний (дата звернення: 25.01.2021). – Назва з екрана.
6. 3D-моделирование: возможности и применение [Електронний ресурс]. – Електронні текстові дані. – Режим доступу: <https://klona.ua/blog/3d-modelirovanie/nabor-besplatnyh-programm-dlya-3d-modelirovaniya>, вільний (дата звернення: 25.01.2021). – Назва з екрана.

7. Архітектурні макети, що виконуються з акрилу [Електронний ресурс]. – Електронні текстові дані. – Режим доступу: http://acrylshik.ru/articles/show/157/Arhitekturnyie_maketyi_iz_akrila, вільний (дата звернення: 25.01.2021). – Назва з екрана.

8. Все, що потрібно знати про 3D друк [Електронний ресурс]. – Електронні текстові дані. – Режим доступу: https://3d.globatek.ru/world3d/osnovy_3D_pechati, вільний (дата звернення: 25.01.2021). – Назва з екрана.

Виробничо-практичне видання

Методичні рекомендації
до практичної та самостійної роботи
з дисципліни

**«АРХІТЕКТУРНЕ ПРОЄКТУВАННЯ:
МАКЕТ ІНДИВІДУАЛЬНОГО ЖИТЛОВОГО БУДИНКУ»**

*(для іноземних студентів другого курсу
денної форми навчання першого (бакалаврського) рівня вищої освіти
191 – Архітектура та містобудування)*

(Англ. мовою)

Укладачі: **ЛЮБЧЕНКО** Марія Анатоліївна,
СМІРНОВА Ольга В'ячеславівна,
РАДЧЕНКО Алла Олександрівна

Відповідальний за випуск *М. А. Вотінов*

За авторською редакцією

Комп'ютерний набір *М. А. Любченко*

Комп'ютерне верстання *М. А. Любченко*

План 2021, поз. 90М.

Підп. до друку 24.02.2021. Формат 60 × 84/16.

Друк на ризографі. Ум. друк. арк. 2,2

Тираж 50 пр. Зам. № .

Видавець і виготовлювач:

Харківський національний університет
міського господарства імені О. М. Бекетова,
вул. Маршала Бажанова, 17, Харків, 61002.
Електронна адреса: rectorat@kname.edu.ua
Свідоцтво суб'єкта видавничої справи:
ДК № 5328 від 11. 04. 2017.