Saimaa University of Applied Sciences
Technology, Lappeenranta
Degree Programme in Civil and Construction Engineering

Aliia Sharafutdinova

# BIM in practice

Bachelor’s Thesis 2015

Abstract
Aliia Sharafutdinova
BIM in practice, 63 pages, 7 appendices
Saimaa University of Applied Sciences, Lappeenranta
Degree Programme in Civil and Construction Engineering
Bachelor's Thesis 2015
Instructors: Mr Timo Lehtoviita, Saimaa University of Applied Sciences, Mr Sergey Veselov, Chief project engineer NCC Company, PhD.

The aim of this thesis was to investigate and identify the present status of applying BIM on practice. Nowadays it becomes more and more adapted in the world when in the process of design creates a computer model of the new building, which carries all the information about of the facility. This topic is actual, because using information modeling is infrequent in Russia. Ministry of construction began implementing the plan for phased introduction of building information modeling technology in the field of industrial and civil construction.

In the first part, the thesis identifies the difference between the information modeling and previous CAD system. Computer-aided design technology BIM allows to visualize in 3D-format all the elements and systems of the building and prepare documentation. Autodesk Revit 2015 benefits were studied as a tool to get results.

The empirical part of this study was conducted at NCC Company in Russia, which is one of the most innovative construction companies on the Russian market, but will to be more efficient. The licensed version of Revit was downloaded and studied. The thesis contents plenty of print screens for making information clear for readers. The project management system in NCC was investigated. During writing a lot of working and design documentation was used. Some important things were found out from BIM conference (St. Petersburg).

In the process of writing the thesis several advantages have been highlighted. And these results suggest that BIM implementation in practice will deepen and cover all construction stages. This survey can be applied as a guideline in further working of the company.

Keywords: BIM, Revit, practice applying

Content

# 1 Introduction

Nowadays BIM has been increasingly adapted in design. The implementation of technology solutions is becoming more and more effective. Optimization and standardization of design company business processes allow a short time and with limited investments increase productivity of designers, reduce delivery time and improve quality of the projects.

Now hardly any design organization asks a question: “Do we really need BIM?” Mostly they ask how to implement the technology. Obviously, adapting BIM requires efforts and understanding from both the management and executors at all levels but then with proper performance informational modeling gives good results.

It is pretty obvious that today Autodesk Revit is the leader among the main BIM-programs in Russia. The reason is that Revit offers a simple and effective end-to-end solution for creating building information models. (WorldCAD Access, September, 2014)

The problem of effective designing and construction is very actual at the moment. Companies tend to build with the lowest spending of time and money.

The *purpose of this bachelor’s thesis work* was to study the opportunities, benefits, possibilities of building information modeling, which supports construction workflow for high-quality design and documentation. *The aim* was to learn more how we can use the BIM tools, how and when does it work, occurring requirements, responsibilities. A*nd the main subject* was practical applying of BIM. The research contains the following steps:

1. The term of BIM;
2. Explanation of the situation with BIM in Russia;
3. Exploring the possibilities of using BIM model in difference stages of design;
4. Practice applying the model in NCC Company.

# 2 BIM

## 2.1 The term Building Information Modeling

These days *BIM* (Building Information Modeling) is very much talked about in the building industry, but definitions are different from different people.

BIM is not just a 3D virtual model of buildings or a collection of all building data, not just a type of software or process. When it comes to BIM everything starts with a 3D digital model of the building. This model, however, is way more than pure geometry and some nice textures cast over it for visualization. *A true BIM model consists of* the virtual equivalents of the actual building parts and pieces used to build a building. These elements have all the characteristics - both physical and logical - of their real counterparts. These intelligent elements are the digital prototype of the physical building elements such as walls, columns, windows, doors, stairs etc. that allow us to simulate the building and understand its behavior in a computer environment way before the actual construction starts.

Information modeling of buildings (BIM) - process of collective creation and use of information about the structure, forms the basis for all solutions throughout the life cycle object (from planning to design, release working documentation, construction, operation and demolition). At the heart of BIM there is a three-dimensional information model, based on which the work of investor, customer, general designer, general contractor and operating organization are organized. (GRAPHISOFT OpenBIM, 2015)

BIM was developed initially as a response to the UK Government requiring better control of information on its centrally funded schemes to provide best value following a number of successful case studies. However, the benefits of BIM have been demonstrated outside of central government and as such BIM is being adopted across the industry.

In 2008 a diagram was developed based on the different maturity levels of BIM. This was then used to establish what standards and practices needed to be developed / updated to allow each maturity level to be adopted.

Figure 1 describes the stages that project teams will go through as they move from traditional processes and methods of drawing to implement fully open collaborative BIM.

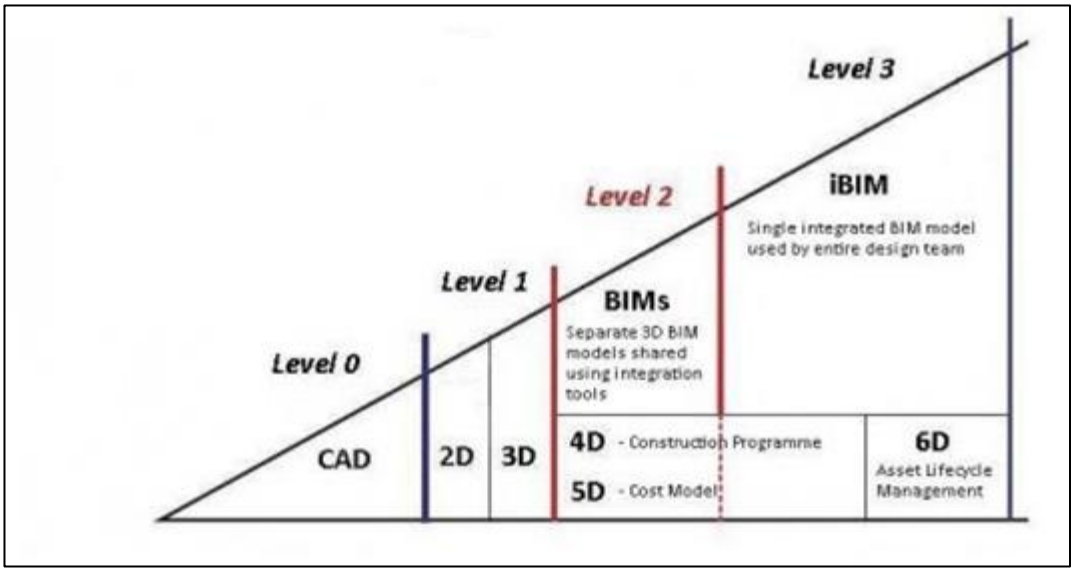



Figure 1. BIM Maturity Diagram (Jos_Voskuil, 2013)

BIM *level 0* is focused on managing CAD, in the other industries this was the time that single disciplines managed their own CAD data. There was no sharing at that time.

*Level 1* is focusing on managing 2D and 3D CAD together much similar to what in other industries is done with a PDM system (Product Data Management). The PDM system manages in one environment the 2D and 3D data. This is still as a departmental solution but could provide in one environment information from different disciplines.

*Level 2* is about sharing 3D BIM models for different disciplines to support 4D (construction planning based on 3D) and 5D (construction planning based on 3D planning and costing integrated).

BIM *level 3* is what can be found currently in the asset centric industries (Energy, Nuclear, Oil & Gas) where working from a virtual plant model all disciplines are connected through the whole lifecycle. (Jos_Voskuil, 2013)

## 2.2 BIM vs CAD

BIM and CAD represent two fundamentally different approaches to building design and documentation. *CAD (Computer Aided Design)* applications imitate the traditional “paper & pencil” process in so far as two-dimensional electronic drawings are created from 2D graphic elements such as lines, hatches and text, etc. CAD drawings, similarly to traditional paper drawings, are created independently from each other so design changes need to be followed up and implemented manually on each CAD drawing. *BIM (Building Information Modeling)* applications imitate the real building process. Instead of creating drawings from 2D line-work, buildings are virtually modeled from real construction elements such as walls, windows, slabs and roofs, etc. This allows architects to design buildings in a similar way as they are built. Since all data is stored in the central virtual building model, design changes are automatically followed-up on individual drawings generated from the model. With this integrated model approach, BIM not only offers significant productivity increase but also serves as the basis for better-coordinated designs and a computer model based building process. (GRAPHISOFT OpenBIM, 2015)

Figure 2 shows relationships between time and different stages of building design in BIM and 2D CAD workflows.

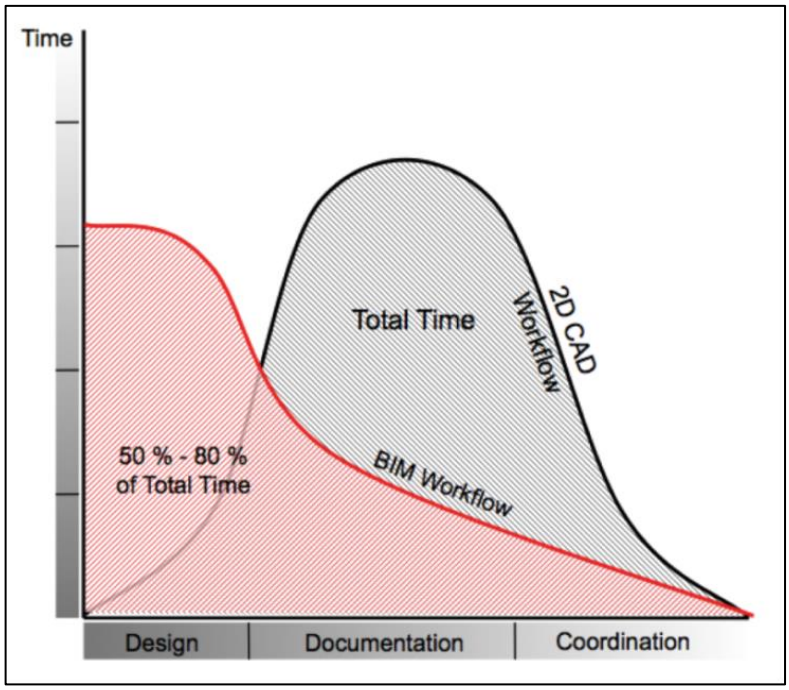



Figure 2. Time-Stage diagram (WorldCAD Access, September, 2014)

## 2.3 Advantages of BIM

The ability to keep information up to date and accessible in an integrated digital environment gives architects, engineers, builders and owners a clear overall vision of their project, as well as the ability to make better decisions faster – raising the quality and increasing the profitability of projects. Here are the top 5 benefits of building information modeling.

1. 3D visualization

While there can be several different goals to fulfill by the creation of a purpose built BIM model that may differ both in their focus, scope, complexity, level of details and the depth of information added to the 3D model, of course the most trivial use of a BIM model is for making nice visualizations of the being to be build. This is good for both helping your design decision by comparing different design alternatives and for “selling” your design to your client or even to the local community that might have a veto about the entire building project.

2. Change Management

Since data is stored in a central place in a BIM model any modification to the building design will automatically replicate in each view such as floor plans, sections and elevation. This not only helps in creating the documentation faster but also provides stringent quality assurance by automatic coordination to the different views.

3. Building Simulation

BIM models not only contain architectural data but the full depth of the building information including data related to the different engineering disciplines such as the load-bearing structures, all the ducts and pipes of the different building systems and even sustainability information as well with which all the characteristics of a building can easily be simulated well in advance.

4. Data Management

BIM contains information that is not visually represented at all. Scheduling information, for example clarifies the necessary manpower, coordination and

anything that might affect the outcome of the project schedule. Cost is also part of BIM that allows us to see what the budget or estimated cost of a project might be at any given point in the time during the project.

5. Building Operation

It is needless to say that all this data put in a BIM model is not only useful during the design and construction phase of a building project but can be used throughout the entire building lifecycle helping to reduce the operation and management cost of buildings which is at least magnitude more than the entire cost of construction. (GRAPHISOFT_OpenBIM, 2015)

## 2.4 BIM benefits

### 2.4.1 Benefits

A single, connected model improves communication within the design and construction teams and the parametric elements of the model create a robust database. The building owner and facility manager can utilize the data within the model during the occupation of the building. Harvesting the information in that database can help everyone be more efficient and also create new opportunities for revenue expansion. Modeling, instead of drawing, is the new paradigm, fostering new cooperation, innovation and building life-cycle savings.

### 2.4.2 Features

*Features* (All 1 Studio, Architecture Engineering Design, October,2013)

BIM – Building Information Modeling – is a co-ordinated set of processes, supported by technology that adds value by creating, managing and sharing the properties of an asset throughout its lifecycle. BIM incorporates data – physical, commercial, environmental, and operational – on every element of a development’s design.

Generally speaking, the benefits of BIM, to the industry, can be categorized into four segments — Pre-Construction benefits, Design benefits, Construction & Fabrication benefits, and Post-Construction benefits.

Pre-Construction benefits:

- Using BIM, building owners can estimate, before the start of actual construction of the building, whether the proposed building design is financially feasible
- If a particular design is over the owner's budget, the owner can easily propose for a new design that can be built within a given cost and time budget.

Design benefits:

- The BIM 3D model can be used to visualize the design at any stage of the process
- While designing, if all the objects used in the model are controlled by parametric rules, ensuring proper alignment, then it can be sure that the 3D model can be constructed in actual sense
- BIM also enables accurate extraction of 2D drawings at any stage of the design process
- BIM also offers adequate information for building performance analysis and evaluation, which is of vital importance for sustainable building design
- Using BIM, designers can analyze the building design in detail and locate human errors, if any
- BIM provides accurate and extremely reliable information about the building, the structure, the materials used, etc. including green aspects such as energy efficiency and day-lighting
- Earlier design visualization also allows for better cost estimates and budget control.

Construction & Fabrication benefits:

- The BIM 3D model can be used to visualize the building and development site with realistic, real-time design scenarios to show it will look like at any point in time
- BIM allows the use of collision detection, which greatly decreases the errors made by design team members as well as the construction team. Here the computer actually informs team members about parts of the building in

conflict or clashing, and through detailed computer visualization of each part in relation to the total building

- BIM operates on a digital database and any suggested design change made to this database is reflected throughout the entire drawing
- BIM produces construction documents that contain information about structure, quantities, materials and other data that can be used in both — the construction and management of a building
- Crowd behavior and fire modeling capability enable designs to be optimized for public safety. Asset managers can use the 3D model to enhance operational safety. Contractors can minimize construction risks by reviewing complex details or procedures before going on site
- Exact quantity take-offs mean that materials are not over-ordered. Precise program scheduling enables just-in-time delivery of materials and equipment, reducing potential for damage. Use of BIM for automated fabrication of equipment and components enables more efficient materials handling and waste recovery

Post-Construction benefits:

- A finalized BIM model provides an accurate source of information about the as-built spaces and systems. It also serves as a useful starting point for managing and operating the building.

(All 1 Studio, Architecture Engineering Design, October,2013)

## 2.5 Stages of Construction

According to Finnish Government, the Model is used at different stages of the construction process.

1. Needs and Objectives (Common BIM Requirements, Series 1 General Part, 2012, pp. 12-14)

The needs and objectives of the owner and end users of the property are assessed (for example, new construction or renovation). Many of the most important decisions are done in early stages.

This stage generates the initial data for the design process: the project's budget and schedule objectives as well as the overall objective for scope, gross area, volume and the total area of different activities.

2. Design of Alternatives. (Common BIM Requirements, Series 1 General Part, 2012, pp. 14-16)

At this stage the most suitable basic solution is investigated using rough spatial models for alternative designs. The design models from each discipline should always be available for each other, which is ensured by agreeing on a sufficiently frequent uploads to the project server. A suitable schedule at this stage could be, for example, linked to the regular design meetings.

The Client's tasks include overseeing the design, comparing the alternatives, and selecting the best design solution for the next stage in cooperation with the future end user of the building.

Three-dimensional modeling and visualization facilitate the comparison between different alternatives and bring the design solutions to a concrete level. In addition to investment costs, life-cycle costs and environmental impact should also be included in the assessment. Comparison of proposed design solutions using simulations is one of the principal benefits of integrated models. Comprehensive comparisons performed at an early stage are important because even radical changes can still be easily made when discussing the general outlines of the project. The later the potential problems emerge in the process, the more difficult it is to resolve them without a major impact on cost or quality.

In the design alternatives stage, a number of alternative solutions are assessed. The architect models the building with space objects with an accuracy that is sufficient for the decision-making concerning spatial arrangements, massing and the outer shell.

The architect's spatial model must be prepared such that space types and the areas as well as the total volume of the building can be automatically obtained from it.

Based on the architect's design proposal, the structural engineer creates a preliminary Building Element BIM for the entire building and detailed Element Building Element BIM for the type structures.

On the basis of areas and room categories, preliminary energy simulation and life-cycle cost estimates can be prepared from the architect's alternatives BIMs, which are to serve as a basis of comparison between alternatives.

Models are convenient for visualization purposes because they help to establish a shared understanding of the alternative design solutions between the stakeholders

3. Early Design (Common BIM Requirements, Series 1 General Part, 2012, pp. 16-18)

In the early design stage, the basic design solution that was selected in the design of alternatives stage and exists in the form of the architect's BIM is developed further. The client's requirements have been updated in the previous stage to confirm to the decision made. At the early design stage, the client's tasks include overseeing the design and approving the design solution for the subsequent detailed design phase. The BIMs enable fast, illustrative and interactive visualization and analyses, which support communication and decision-making.

*The architect* develops the selected design alternative into a Preliminary Building Element BIM. At the end of the early design stage, the BIM must contain at least the following:

- Load-bearing structures: pillars, columns, slabs and walls;
- Wall categorized according to the main type (external walls, light partition wall, etc.)
- Windows and doors

*The structural designer* must confirm the dimensions, requirements and impact on the work of other designers of the structural system.

*The HVAC designer* must confirm the spatial requirements of the systems and their impact on the work of other designers. The model must contain the spatial requirements of main ducts and machine rooms to the extent.

*The electrical designer* must define space requirements for those parts and components of electrical, telephone and data communications systems that have impact on space allocation.

4. Detailed Design (Common BIM Requirements, Series 1 General Part, 2012, pp. 18-20)

Design solutions will be finalized to a level of accuracy that is required for calls for tenders, and all models prepared for the project will be further specified using detailed type information.

At the detailed design stage, the Client's tasks include overseeing the design and approving the design solutions. The visualizations and analyses enabled by the BIMs provide support for communication and decision-making. At the end of this stage, the detailed design solutions will be approved to the extent that they can be used for advancing to the tendering stage.

The BIM must be used for visualizing the design solutions.

Bills of quantities and cost estimates based on them will be prepared on the basis of the checked BIMs. The bills of quantities will also be used in the contract tendering stage.

On the basis of the detailed design information, the models prepared in the detailed stage can be used for generating the final energy simulations and life-cycle cost calculations, which can then be compared with the actual costs during the occupancy of the building.

5. Contract Tendering Stage (Common BIM Requirements, Series 1 General Part, 2012, p. 20)

At this stage, the BIMs and the bills of quantities, visualizations and other documents generated from them will be handed over to the contractors for the

purpose of facilitating the preparation of tenders and preliminary planning of the construction work.

With the help of three-dimensional BIMs, visualizations and other information obtained from the models, the contractors are better able to familiarize themselves with the design plans and the construction site. The tenders must be based on the quantities presented in the original call for tender.

6. Construction (Common BIM Requirements, Series 1 General Part, 2012, pp. 20-21)

The 3D visual nature of BIMs is a significant benefit of models in many different situations. Models are a good way to study the designs and structures and to plan installation of the work.

The BIM based quantity take-offs speed up the calculation process and give a more accurate result, assuming that the modeling is done properly and without errors. Model-based quantity take-off and report templates reduce a significant amount of duplicated work, which improves the productivity of construction.

Contractors and designers can use BIM to study the installation of prefab and in-situ cast structures, installation order of different building services, temporary supports etc. If all temporary supports and structures are also modeled, the model can help you to study the security and logistical issues for them as well.

The site can utilize the BIMs also in meetings for HVAC installations, in which the work sections and order are studied with contractors in order to ensure the schedule compatibility among the various contractors.

7. Commissioning (Common BIM Requirements, Series 1 General Part, 2012, p. 21)

From the point of view of modeling, the most important documents generated at this stage are the As-built Models and the maintenance manual.

BIM-based maintenance manuals are currently in a developmental stage and thus only required in exceptional cases.

All BIMs required for the project must be supplemented in the construction stage to reflect the modifications made so that they correspond with the end result ‘as-built’.

As we can see, BIM covers all stages of the life cycle of buildings: planning, technical task, design and analysis, the issuance of working documentation, manufacturing, construction, operation and maintenance, dismantling. See Figure 3.

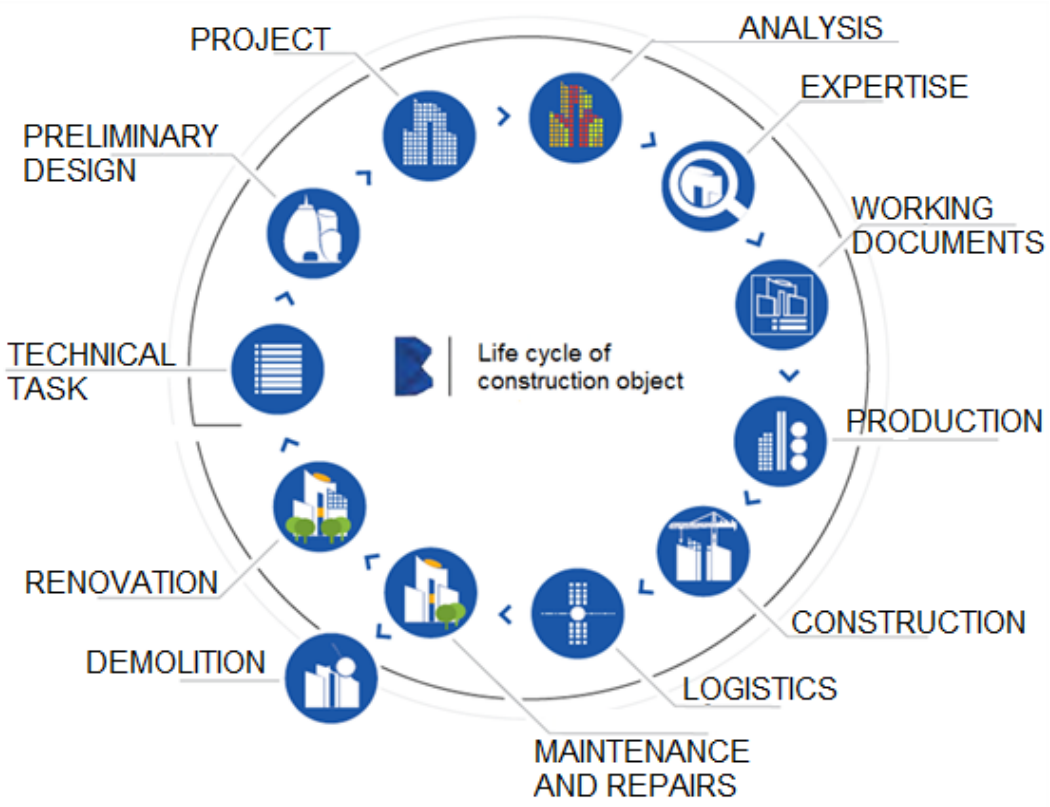



Figure 3. Life-cycle of construction object (Julie Kyle, 2012_March)

## 2.5 Different types of BIM according to Project phase

### 2.5.1 Project Requirements

(Common BIM Requirements, Series 3. Architectural Design, 2012, pp. 11-12)

The very first phase of the project involves a study of the necessity of the project, an initial description of the spaces and their requirements, an

examination of operation alternatives and of the overall cost of these alternatives.
At the beginning of the project, the form of the BIM may be different from a normal three-dimensional model. It is important to maintain and update the BIM content during the design process.

Requirement BIM

The minimum requirement for a BIM is the functional program in a form of a spreadsheet or a database table. This table can be used to compare the program and the design solutions.

The requirements that are presented in the functional program are, for example:

- Net area requirement for each space and, where appropriate, size and shape requirements;
- The main function and users of the space;
- The essential connections to and impacts on other spaces;
- Indoor climate, sound insulation, lighting, load, durability, safety and quality requirements;
- HVAC systems, electrical systems, fixtures, fittings, equipment, space dividers, surfaces.

2.5.2 Project Planning and Design Preparation

(Common BIM Requirements, Series 3. Architectural Design, 2012, pp. 12-13)

Project planning is based on the initial project requirements. In this phase the different methods of project implementation and feasibility of alternatives are examined. During the design preparation stage, the design guidelines are organized, a possible design competition is held, necessary negotiations are conducted, designers are selected, and design contracts are made.

In the project planning phase, the architect uses a model of spaces to study various design options and their costs by utilizing area-based analyses. In addition, the model may be used for energy and indoor climate simulations in order to support the life-cycle costs and assessment analysis.

Inventory BIM

The initial model of a building is called the Inventiry BIM. Initial data:

- Existing building and structures
- 2D drawings
- 3D models and images
- Scanning and other measurement results
- Site measurements

Site BIM

A ‘Site BIM’ refers to the model of the construction site and its environment, yard, vegetation, traffic areas and regional structures. The unit of measurements, and it is created in the same coordinate system as the building.

2.5.3 Sketch Design

In the sketch design phase, alternative design proposals are created in order to meet the objectives set in the previous phases. Following a comparison of the proposal, the base design solution for the next phase is selected.

Spatial BIM

The ‘Spatial BIM’ consists of spaces and walls that surround them.

A special case of the Spatial BIM is a model that contains only spaces. Such a model can be used in the early phases of a project as an aid in preliminary design and for creating room reports (directly from the model). This simple model is frequently supplemented by a variety of 2D components, which are replaced with walls and other building components in later design phases.

As the design is developed, the Spatial BIM becomes a part of the Building Model. As the model becomes more complex, however, the compability of different analysis software often becomes problematic or even impossible. In this case, it may be necessary to make a simplified version of the Building Model which has similar properties to Spatial BIM.

Three dimensional spaces, space groups and volumes are modeled in such a way that their geometries can be used to automatically calculated areas and volumes.

If the Spatial or Spatial Group BIM is modeled without partition walls, the default space area either includes the footprint area of the walls, or the spaces that have been places within an estimated wall distance from each other.

The following spaces are modeled into the main model or into a separate file:

- Net area

Each individual space has a net area boundary enclosed by the internal surface of walls excluding the columns, load-bearing walls and the chimney area.

- Gross Area

The gross area space is modeled into each building storey and its height is the height of the story from the top of the floor finish to the top of the floor finish on the floor above.

- Other Areas

Other areas that need to be included in the model are defined by the client or in the project agreement. When definig other areas, it must be taken into account that some areas, such as apartments and departments, can be exactly the same thing and therefore only one of them is required in the project.

- Volume (Spaces, Space Groups and Gross Area)

Volume information is defined by the geometry of the spaces, and should be transferred to IFC format. Spaces must comply with the height of the room – measured from the top of the finished floor to the lower surfaxe of the slab above.

The benefits of the Spatial Model are as follows:

- Preliminary quantities
- Room schedules
- Overall area and volume information

- Grouping of spaces
- Initial model for simulations
- Visualizations
- Site planning and massing models

### 2.5.4 General Design

(Common BIM Requirements, Series 3. Architectural Design, 2012, pp. 17-18)

In the general design phase proposal are developed towards the final design. *Building Element BIM*

The Building Element BIM includes building elements in addition to spaces.

The drawings needed for a building permit application are produced from the Building Element BIM. Building permit drawings and other documents must meet the level of accuracy and content of the standards set by building authorities.

### 2.5.5 Detail Design Phase

(Common BIM Requirements, Series 3. Architectural Design, 2012, pp. 18-21)

The final Building Element BIM is typically finalized in the bidding and detail design phase. All the building components in the model are specified with the same types as are defined in the Construction Specifications document.

The benefits of the Building Element BIM in the Detail Design Phase:

- Quantitites of windows, doors and other building elements;
- Room schedules;
- Overall areas and volumes;
- Grouping of spaces;
- Model for the simulations
- Visualizations
- Site planning and mass models
- Support material for the bidding (3D models for viewing);

- Clash detection;
- Preliminary construction planning.

2D Drawings and Plots:

- General drawings
- Detailed drawings
- Plan views
- Sections
- Facades

2.5.6 Construction

(Common BIM Requirements, Series 3. Architectural Design, 2012, p. 22)

Construction control ensures the conformity of the contract execution and that the end result meets the objectives and the necessary operating and maintenance capabilities.

An on-site model is used in the supervision and management of construction schedule. The level of accuracy required in the architectural model during the construction phase must be agreed in accordance with the need of the construction site.

2.5.7 Reception

(Common BIM Requirements, Series 3. Architectural Design, 2012, p. 22)

As-Built BIM

As the building is complete, the architect must update the Building Element BIM to correspond the final implementation. The goal is for the final BIM to correspond the end result ‘as-b uilt’ and can be used as the basis for facility management, building maintenance amd modifications made during occupancy.

### 2.5.8 Implementation and Maintenance

(Common BIM Requirements, Series 3. Architectural Design, 2012, p. 22)

During the warranty period the building performance will be monitored, necessary adjustments and inspections are made, and corrections to any deficiencies are carried out.

Maintenance BIM

A maintenance model can help with facility and property management during the life cycle of the building. The results of Indoor Climate Simulations carried out in the design phase can be compared to actual conditions.

The process of BIM used in the different phases of the Project is shown in Figure 4.

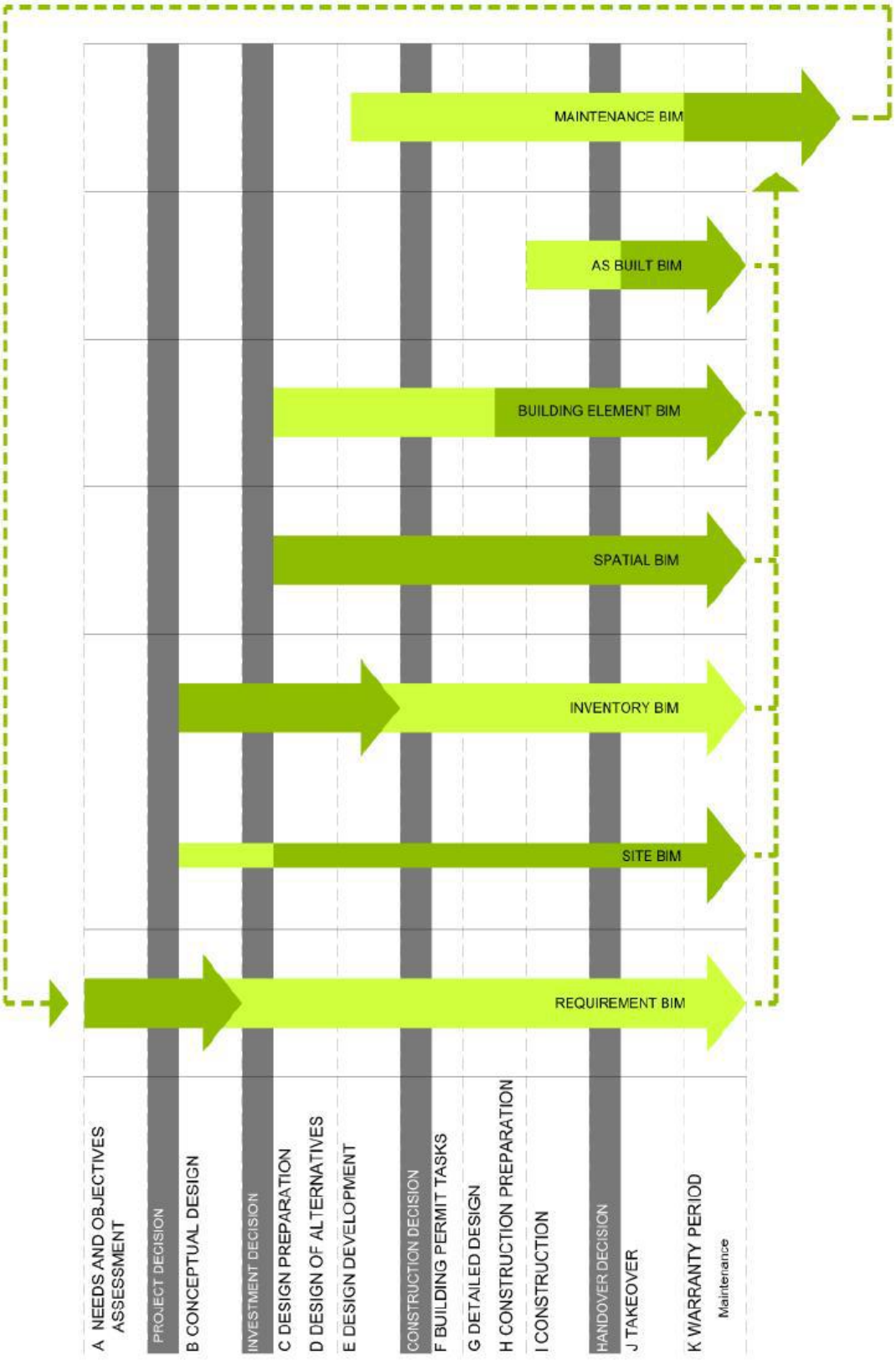



Figure 4.The Use in different phases of the Project

(Common BIM Requirements, Series 3. Architectural Design, 2012, p. 11)

## 2.6 Difficulties in the implementation

(InfoComm, BIM Taskforce Brochure, 2015, pp. 11-12)

BIM has the potential to improve the communication and coordination between the different stakeholders of a project. BIM's benefits range from simple improvements in efficiency to greater client satisfaction.

With all of the perceived benefits of BIM, professionals should also be aware that there are a number of considerations and current limitations that must be taken into account.

*Cost of Software and Hardware*

Every organization currently utilizing 2D or 3D CAD drafting software can attribute a cost element against purchasing, maintaining and upgrading software licenses to keep a competitive market advantage. Current trends show that the cost of BIM software packages tends to be more expensive than CAD software packages available on the market.

With the introduction of BIM software, the requirements on hardware have increased significantly. Currently, CAD software can be operated (with limitations) on a vast majority of professional laptops. Yet with the introduction of BIM software, dedicated high-specification workstations, equivalent to those required by advanced modeling and rendering software, are required.

Software and program requirements are ahead of hardware availability. With BIM software, it is essential to know exactly what parameters of the hardware improve performance and what elements have no major effect at all.

*Cost of Training*

With new software, there is a great demand to train staff quickly so that the investment can be justified. It is not realistic to assume professionals with CAD proficiency will be able to learn new BIM software quickly or without specialized training. Given the fundamental differences between BIM and CAD, training should be considered a requirement for all professionals involved with designing and producing documentation.

BIM provides the ability for every member of the team to be involved in the design and modeling process, giving them complete control of the end product. Investment in training for early adopters provides them a competitive edge with projects that have clearly specified requirements to be documented utilizing BIM.

*Transition from Drafting to Modeling*

When moving from a CAD-based drafting to a BIM-based modeling environment, a change in the workflow will surround what used to be simple drafting tasks such as copying markups or picking up redlines. These tasks now require a higher-level skilled design drafter who has an understanding of the project and the used materials. The costs associated with training and maintaining a skilled design modeler are higher than a draftsman with no knowledge of the trade.

The transition from traditional CAD will also place an increased level of responsibility on the designers to ensure that all systems components are coordinated with the other professionals such as architecture and engineering services and that site issues are reduced to a minimum.

*Compatibility between Software Platforms*

One of the biggest issues with early adaptors of BIM is the issue of inter-product compatibility. Due to the relatively new nature of the market, every software manufacturer is doing something different with its software. The interoperability challenge can make it difficult for projects to function if different team members own different software packages.

This interoperability issue is not limited to different software platforms; due to the rapid development of the BIM software industry newer versions of programs within the same platform cam have interoperability applications.

One alternative to the current product-specific models is a vendor-independent neutral-file format. One such file format is the Industry Foundation Classes (IFC) format which captures both geometry and properties of intelligent building objects (objects with associated usable metadata) and their relationships with

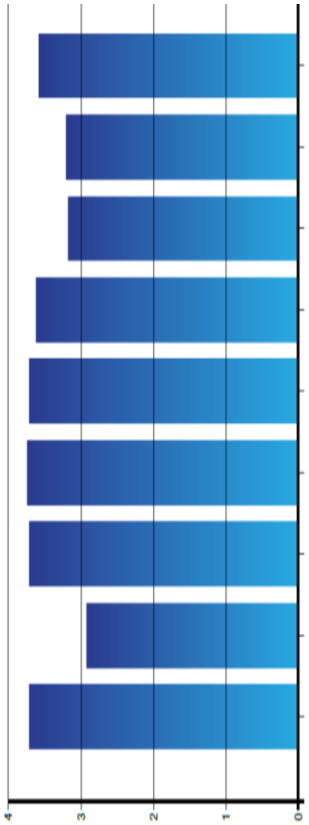
Building Information Models, this is facilitating the sharing of information across otherwise incompatible applications.

*Innovation*

Since a goal of BIM is to assign constraints and parameters to intelligent objects to improve efficiency, there is a potential to inhibit innovation which would possibly otherwise occur without the automated processes and shared knowledge that BIM now provides. Those firms implementing BIM should view the parameters and metadata constraints as a global database that allows designers to save time associated with updating and configuring product - specific data repetitively on different projects, hence increasing the amount of time spent on system design and innovation.

(InfoComm BIM, Taskforce Brochure, 2015, pp. 11-12)

Figure 5 shows the scale of difficulties which appear during the implementation:




Realizing the value from a financial perspective

Understanding and mitigating liability

Understanding BIM enough to implement it

Establishing the new process/ workflow and defining expectations

Effectively implementing the new process/ workflow

Training personnel on new software technology

Training personnel on new process workflow

Purchasing software

Training personnel when getting started with BIM

Conclusion: all of them are very hard and difficult.

The most difficult ⟷ The easiest

Figure 5. Scale of the application difficulties (Jos Voskuil, 2013)

# 3 BIM from the perspective of state standard in Russia

## 3.1 The gap from the West

In some countries of Europe and also in China, Singapore and South Korea the use of BIM is obligatory in the design. And BIM is appropriated a status of national standard. But the situation in Russia is different. There is an obvious lag: only 5% of the design institutes have the opportunity to perform building information modeling. Expertise specialists have problems with reading 3D models.

The authorities have plans to transfer Western experience. The first step was the approving of the plan for the implementation of BIM in the end of 2014. At this stage it is already possible to note some successes, one of the BIM projects was examined in Moscow, and other two are in the active stage.

In order to determine the adjustments it is planned to start pilot projects using 3D design. These projects are selected by:

- The company's experience in BIM;
- Availability of specialists;
- The use of 3D models in the three stages of the project.

Another important question is personnel training, preparation. For example, there are BIM-managers allocated for every project in the West. The available human staff is limited in Russia. (Civil+Structural_ENGINEER, 2012)

## 3.2 The development plan

The Ministry of construction and housing utilities of the Russian Federation approved phased implementation of information modeling technologies in the field of industrial and civil construction. A selection of pilot projects with the use of BIM was carried out. According to the analysis of the selected projects examination will define a list of legal, regulatory and technical acts, educational standards, subjects to change and develop. (Olga.Dashkova, 2015)

The Plan of the phased BIM introduction in the field of industrial and civil construction design is shown on the following table.

Table 1. The phased BIM introduction Plan

(The Ministry of Construction of Russia, 2014)

| Name of action | Executer | Due date |
|---|---|---|
| Selection and direction to the Expertise first “pilot” projects, the design of which was realized with application of information modeling technologies in the field of industrial and civil construction | The government of the Russian Federation expert Council, the Ministry of construction of Russia | March, 2015 |
| The examination of the pilot projects by the Expertise, which were prepared by using the information modeling technology in the field of industrial and civil construction | The bodies of Expertise "the Main state expertise of Russia", the Ministry of construction of Russia | April-November, 2015 |
| Analysis of the results of the design and expertise of projects, prepared using information modeling in the field of industrial and civil construction, the definition of the list of normative legal and normative technical acts, education standards, subject to amendment and development | Report to the Government of Russia Federation | December, 2015 |
| Alteration of the normative legal and normative technical acts | Normative-legal acts, normative technical acts, educational acts | December, 2016 |
| Education Training in the use of informational modeling technology in the field of industrial and civil construction | | December, 2017 |

During the creation of the Registry of typical design documentation undertaken by the Ministry of construction of Russia, the preference will be given to projects presented in a three-dimensional format, using BIM technology. In addition, special attention will be given to the functionality of the projects, especially social unit.

The formulated criteria for the pilot project will become experience in implementing projects using BIM technologies, the availability of professionals working with BIM technologies and to regulate the process of information modeling documents and using on the project a unified information model of the main sections of the project (architecture, design, estimates, etc.) and controlling 3D environment.

The Ministry hopes that the implementation of the action plan for phased introduction of BIM technology will increase the competitiveness of the construction sector in the global market, improve the quality of survey, design and construction of facilities, reduce the cost at the stage design and examination of project documentation, as well as reduce the risks of emergencies.

The office noted that the practice in the process of architectural design creating a computer model of the new building, which carries all the information about the future of the site, is increasing currently. CAD (computer-aided design) on BIM technology allows you to visualize in 3D all the elements and systems of the building, to count different layout options, and to bring them into conformity with applicable regulations and standards, to analyze the operational characteristics of future buildings, simplifying the choice of the optimal solution, stress in the Ministry of construction. (Yirii Reilyana, The Ministry of Russian Federation, 2015)

# 4 Revit

## 4.1 Basics of Revit

Autodesk Revit is a software complex Building Information Modeling (BIM). It provides users the ability to design, parametric 3D modeling and 2D drawing elements, makes it possible to organize joint work on a project from concept to production of working drawings and specifications. Building information modeling is a system of computer-aided design (CAD), which uses intelligent 3D objects to represent real physical building components such as walls and doors.

In addition, the Revit database may contain information about the project at various stages of the life cycle of buildings, from concept to construction and decommissioning. This is sometimes called 4D CAD, where time is the fourth dimension.

This software provides structural engineers and designers with the tools to more accurately design and build efficient building structures. Built to support Building Information Modeling (BIM), Revit helps to use intelligent models to gain project insight through simulation and analysis and predict performance prior to construction. The document designs more accurately using coordinated and consistent information inherent in the intelligent models. (InfoComm BIM Taskforce Brochure, 2015, p. 5)

## 4.2 The possibilities of Revit

The usefulness of the Revit is great, its possibilities are:

- To create not just separate geometrical objects such as lines, arcs or circles, but to create and place a virtual representation of the building with division by structural elements. It has information about the object such as material, size, hardware and much more.
- To create a number of drawings which are referenced together to produce sheets that in the end become the construction documents. Multitude

of people can work on the single file at one time. Each can be notified by collaboration tools in Revit when the object in the models was changed.

- A model of a building in one single file where the drawings are live representations of the model is generated in Revit program. All the drawing changes that were made in the model update quickly.
- A database of information is created in Revit program. This program is such judicious that it will never put an object in a wrong place. All information is interrelated. Any view in Revit is simply created by a query to the database in a tabular or graphic way. The drawings which are made by BIM are the secondary information.
- During the process of 3D modeling on the basis of 2D drawing plenty of errors can appear. Now 3D models are full of information. The program can run interference to find clashes that may not be found in traditional 2D CAD until the project was under construction.
- All information about the project: architecture, structure, mechanical, electrical and plumbing parts of the building design industry is included in one model which facilitates management of the model visualizing and reduces time for changing.
- Earlier a team of designers focused on drawings: some of them might work on plan drawings, others on elevation drawings. In BIM the team focuses on adding information to the database which in its turn creates the drawings.
- Revit tools help to calculate detailed material. Every single change in any sheet leads to changes in the whole project such as drawings and specifications.

# 5 Housing development in NCC Company

NCC Company is an up-to-date company. It needs to develop new technology and use it in practice.

## 5.1 The Project Skandi Klubb

The work began with creating the model of building. The object is located at the address Aptekarsky Prospect 16, B. The total land area is 3.8 he. The total number of apartments is approximately 1213 pieces. The total area of the apartments is approximately 78,000 m². There is an underground parking, including 36 pieces on the ground. The residential complex includes a built-in kindergarten in 2 buildings for 100 children and a commercial part for a supermarket. The land plot has been divided by 4 residential groups. The foundation: piles 16 m in length with sheetpile retaining wall setting (because of geological situation – river Bolshaya Nevka impact). The master Plan is shown on the Figure 6:


Figure 6. The Master Plan of Skandi Klubb

The buildings are constructed from prefabricated elements. Self-supporting walls are reinforced concrete single-ply panels. Load-bearing external and internal walls are precast reinforced concrete panels. Internal walls (2-9 floors) are precast reinforced concrete panels with individual production. Internal walls (1, 10 floors) are made of in-situ reinforced concrete. External walls are precast single-ply reinforcement concrete panels with insulation and decorative cladding. The ground floor is made of in-situ reinforced concrete with native or imitative stone facing.

Types of roofing are as follows:

- Green roof;
- Operated terrace roof;
- Pitched roof;
- Flat roof.

The specialties of the Project are using unified engineering unit (transmits all communications: ventilation, sewage, water supplying) and heat recovery system (mechanical exhaust ventilation).

Windows are made with energy efficient glazing. Sound insulation is higher than the norm. French balconies are used in the Project (historic construction place features). The facades are made with plaster tracery. (NCC.Projectia, 2014)

The first group includes:

- 2 buildings, 8 sections, 8, 9, 10, 11 floors
- 348 flats, total area is 21 470 m².

## 5.2 Used Programs in NCC Company

Used Programs in NCC Company (Sergey Veselov, 2015)

There are different programs which are used during all stages of construction. All of them are shown in the following table.

Table 2. Used programs

| Pre-project | | Project Documentation | | Working Documentation | |
|---|---|---|---|---|---|
| The concept of landscape design | - | The planning organization of land Scheme | - | General Plan | - |
| | | Landscape design project | - | Detailed Design of Lanscape design | - |
| The architec-tural concept | Stech up | Architectural Design | Revi | Architecture Design | Revit |
| | | | | FRS Floor Plans | Revit |
| | | | | Furniture Plans | Revit |
| | | | | Design Project of Common Areas | Revit |
| | | | | Design Project of Façade lighting | - |
| | | | | Demonstration Materials | Revit |
| | | Vertical Transportation | - | Vertical Transportation | - |
| | | The insulation and the natural illumination coefficient calculation | Solaris - SITIS | - | |
| - | | Structural and Space-planning decisions | Lira-SAPR, SCAD office | Constructive Solutions - monolithic design | SCAd office<br>Lira SAPR |
| | | | | Constructive Solutions -concrete | |
| | | | | Constructive Solutions - metal | |
| | | Geotechnical study of the Project | Plaxis | - | |
| | | Thermotechnical calculation | Lira-SAPR SCAD office | - | |

| | | | | |
|---|---|---|---|---|
| - | Electrical power system | Magi CAD | Electrical power system | Magi CAD |
| | Water system | | Water system | |
| | Drainage system | | Drainage system | |
| | Heating system | | Heating system | |
| | Ventilation system | | Ventilation system | |
| | Air conditioning system | | Air conditioning system | |
| | Heating networks | | Heating networks | |
| | | | Heat supply system | |
| | Technical solutions - kindergarten | | Technical solutions - kindergarten | |
| | Technical solutions - parking | | Technical solutions - parking | |
| | Technical solutions - supermarket | | Technical solutions - supermarket | |
| | Wired radiobroad casting | | Wired radiobroad casting | |
| | Cable television system | | Cable television system | |
| | Terrestrial television system | | Terrestrial television system | |
| | Telephone network and the Internet | | Telephone network and the Internet | |
| | Video surveillance system | | Video surveillance system | |
| | Access Control system | | Access Control system | |
| | Dispatching system | | Dispatching system | |
| | Integrated Automatization | | Automation system of general ventilation and air conditioning | |
| | | | Automation of water supply and sewerage | |
| | - | | Combined plans of house Networks | |

| | | | | |
|---|---|---|---|---|
| - | Project Construction Management | - | General Plan of Building updating | - |
| - | Draft organization of demolition and Dismantling | - | - | |
| - | The list of Measures to protect the environment during the Construction | - | - | |
| | The list of Measures to protect the environment during the Operation | - | - | |
| | Technological regulations for Handling Construction waste | - | Standards for waste and Limits of its distribution | - |
| - | Activities for fire safety | - | Automation system of fire protection | Magi CAD |
| | | | Automatic installation of fire extinguishing | |
| | | | Automatic fire Alarm | |
| | | | Automated system of Gas Control | |
| | Fire risks calculation | - | Fire risks calculation | - |
| | Special Technical Conditions | - | - | |
| - | Measures to ensure disabled people access | - | - | |
| | Measures to ensure compliance with the energy efficiency requirements | - | Project certification in accordance with the standards of energy efficiency | BEM - building energy modeling |
| - | The requirements for the Safe Operation of capital construction | - | - | |

*(Appendix 1)*

### 5.2.1 Pre-project

In accordance with the Russian legislation, the Task for Design shall be prepared and approved by NCC in cooperation with chosen designers. It is also necessary to agree the Task with authorized state bodies, depending on the purpose and social value of the project.

Apart from general Task for Design, NCC together with the designers prepares Technical Conditions for Construction Design, describing the intended-for-use building materials and structures, as well as all project utilities in detail. In order to draw up this document, it is essential to cooperate with the suppliers of various materials and equipment (procurement department), and also to explore potentially more efficient solutions.

### 5.2.2 Project Stage

In the Project Stage, also known as Stage P, the design is developed in accordance with the design schedule (in which time, cost and party responsible for each stage is pointed out).

Design documentation is prepared according to the Technical Task for Design and local legislation. In addition to design documentation, initial data and results of engineering surveys (detailed requirements to which are specified in ancillary acts of State Expertise) are delivered for State Expertise.

NCC is mainly in charge of:

- Checking of the design documents from the quality and cost point of view
- Cost management, including control of the effectiveness of design choices
- Timely providing of initial data and comments to the design documentation.

The Main Designer is mostly in charge of:

- Arrangement of effective work collaboration between the design organizations
- Conformity of design sections to each other and their full compliance with the approving agency requirements

- Full compliance with NCC requirements and government regulation.

### 5.2.3 Working Documentation

Prior to preparation of Working Documentation, NCC must give designers a Task for Working Documentation with most detailed indication of all decisions in all design sections, including space-planning decisions (they are better to be defined after consultation with the property management organizations), engineering solutions, sales department proposals, finishing decisions, security and dispatching proposals, water supply and sewage, heating and ventilation, etc.

When preparing Working Documentation, NCC shall be quick in making decisions on issues related to the project: carrying out the required adjusting surveys, working actively with monopolists and approving agencies, helping designers to find the required design solutions or manufacturers of required building units and details. As the drawings are drafted, they must be timely revised and commented for corrections.

After WD working out, NCC shall officially receive from the designers the set of Working Documentation in agreed number of copies, which hereafter is transferred to the General Contractor, bearing a stamp «released for construction». (NCC.Projectia, 2014)

## 5.3 Adaptation of BIM technology introduction

Project Engineers are equipped with Apple iPad for use on construction sites with drawings. (Vladimir Alexandrov, 2015). Advantages of that:

1. Reducing the number of printed paper
2. Reducing the cash costs associated with printing the working documentation
3. Increasing the efficiency of work with drawings
4. Convenience and speed of updating drawings
5. Convenience at the site – compactness

6. Testing download 3D models in the tablet and on-site examination of complex engineering systems installation in inconvenient conditions.

# 6 Practice applying of model

(Sergey Veselov, Chief Project Engineer, 2015)

Here are the top of actual use examples of building information modeling technology in practice.

## 6.1 Information for the client

a. All information from model uses in a contract
b. Salescase

This is a special document, which contains preparation of selling material. Designers prepare it for the sales department in order to answer all necessary customer questions (includes both technical and architectural parts).

The selling brochure is prepared already at the beginning of the possible preliminary marketing when the customer's interest in the product can be maximized. Upon completion of preliminary marketing the same brochure can be used in the selling phase unless there are changes during the preliminary marketing phase as require updating and re-printing of the brochure. When preparing the selling brochure the architect is expected to provide the complete and final list of apartments which serves as a basis of entering the housing association in the accounting system and preparation of the price list.

c. 3D printing
d. 3D maquette[1]
*e.* demonstration materials *(Appendix 2)*

---

[1] Video clip of 3D maquette making link *https://www.youtube.com/watch?v=_m-B9S76AmU&feature=youtu.be*

Benefits from the Model for tender phase are as follows:

- Visualization of design
- Quantity take-off
- Part of combined model
- Planning of occupation safety and construction area
- Planning the construction schedule
- Base of the next design phase

(InfoComm, BIM Taskforce Brochure, 2015)

### 6.2 Federal Registration Service Plans

A federal agency in Russia, responsible for the organization of the Unified State Register of Rights on Real Estate and Transactions, as well as the spatial data infrastructure of the Russian Federation.

(Appendix 3)

### 6.3 Building exterior

- Using the model allows to get all facades from different sides, situational plans, in perspective automatically
- Common areas (stairs, corridors, entrances)
- Visualizations
- Site planning and massing models

*(Appendix 4)*

### 6.4 Specifications and schedules

- Room schedules
- Numbers of the apartments
- Area and volume information
- Grouping of spaces
- An apartment balance
- Quantities of the parking places
- Quantities for windows, doors and other building elements

This information is necessary for working documentation, to make production database. (Sergey Veselov, 2015)

*(Appendix 5)*

Gross Area (InfoComm, BIM Taskforce Brochure, 2015)

The gross area is modeled into each building storey and its height is the height of the story from the top of the floor finish to the top of the floor finish on the floor above. This space is used for analysis, calculation of key indicators as well as in the detection of missing or overlapping spaces.

Other Areas

Other areas that need to be included in the model are defined by the client or in the project agreement. When defining other areas, it must be taken into account that some areas, such as apartment and department, can be exactly the same thing and therefore only one of them is required in the project.

Volume

Volume information is defined by the geometry of the space, and should also be transferred to IFC format. Spaces must comply with the height of the room – measured from the top of the finished floor to the lower surface of the slab above or, in some cases, to the bottom of the ceiling.

## 6.5 MagiCAD for Revit

(magicad.com, MagiCAD for Revit, HVAC&energy) *(Appendix 6)*

- Drawing of electricity serves as a base for panel drawings (all needed holes)
- Automatic ventilation calculation (hole diameters in panels)
- All the necessary components sizing
- Dimensional ducts, pipes
- Ventilation layout – ceiling changes should be shown on the drawings
- Calculate pressure drops
- Calculate sound levels
- Analyze flow data

- Designing and calculating sprinkler systems (calculation of required system pressure based on the hydraulically most remote area)
- Calculation of actual flow density for each sprinkler head
- Determines working order (step by step, what should be done first)

## 6.6 IFC-file

The architect must provide spaces with numbers, functions, areas and volumes in the native format of the software as well as in IFC format.

(Common BIM Requirements, Series 3. Arcitectural design, 2012, p. 10)

IFC – file

It is a platform neutral, open file format specification that is not controlled by a single vendor or group of vendors. It is an object-based file format with a data model developed to facilitate compatibility in the architecture, engineering and construction (AEC) industry, and is a commonly used collaboration format in Building information modeling (BIM) based projects. The IFC model specification is open and available.

In fact, this gives an ability to combine different plans.

Any later changes or updating the original IFC file reflect the Revit model after re-open or reload.

## 6.7 Solibri

The decision made by Solibri finds potential errors of the project before construction and installation works start. The program allows to perform a checking the information model of the object to detect collisions, to check the conformity of the model with the requirements of the standard BIM, to compare models and to extract the necessary information.

*(Appendix 7)*

Solibri Model Checker capabilities are as follow:

1. Automatic analysis and grouping of collision by specific parameters.

There is quick and effective detection of project errors, quality assurance of BIM models.

2. Automated search of missing materials and components.
3. Verification of compliance of the elements of architectural and structural models.

Determination of the errors and incorrect models is created by specialists of related sections. Due to the constant updating of used models, expensive corrections are eliminated.

4. Control of project changes in different versions.

Controlling and monitoring changes of the original and current versions of the same model. Due to the convenient visualization and verification of model changes time is saved.

5. Rapid search and extraction of the information from BIM model.

It is possible to instantly calculate area and material volumes, rapid extraction of all necessary information.

### 6.8 Preliminary meeting

This is important part of construction. Frequency of working group meetings depends on the current design phase. Main Designer together with the NCC prepares a brief agenda (повестка) in advance and forwards it to other design participants. Managers of every design group update the agenda and select meeting members.

- Project engineers describe all the models, take into account comments
- Identify key moments

### 6.9 The basis for other projects

Ready made plans and sections could be used in further projects. In the Pre-Project stage BIM of one Project relates with another (considering other conditions). It saves a plenty of time, prediction of mistakes.

## 6.10 Energy efficiency

- effective solutions for thermal insulation and energy consumption
- getting a standard certificate GREEN ZOOM

GREEN ZOOM - adapted for the Russian version of the American LEED standard and British standard BREEAM.

Reduced resource consumption - investment and operating costs of the project reduction. (Sergey.Veselov, 2015)

# 7 Conclusions

BIM is important revolution in the construction and building management industries, and the firms that can quickly become competent adopters will have an edge on the competition. With increased profitability, reduced professional risk, less waste, less rework, and improved efficiency, these firms can use BIM to create new revenue streams and to add profitability. I am convinced, BIM will be the main method in which buildings are constructed and managed. It is crucial for companies to become early and professional adopters of this technology and embrace the associated cultural change to ensure the growth of the industry.

Having said that, it is important to remember about current limitations. Significantly, with new software, there is a great demand to train stuff quickly so that the investment can be justified. It is not realistic to assume professionals with CAD proficiency will be able to learn new BIM technologies quickly or without specialized training. Given the fundamental differences between BIM and CAD, training should be considered a requirement for all, who involved with designing and production.

Every member of the team need to understand that he/she is able to be involved in the design and modeling processes, to complete control end product. That is why it is crucially to train early adopters, providing them a competitive edge with projects that have clearly specified requirements to be documented utilizing BIM.

The design and construction industry is experiencing real, measurable impact from the adopting of BIM. This impact is not just due to the software, but how it alters industry wide design and construction processes, encouraging collaboration, prefabrication and other ways to make those processes more efficient and productive.

## Figures



## Tables

# 7 References

All 1 Studio Architecture Engineering Design. (October,2013). Revit benefits.

Civil+Structural_ENGINEER. (2012). Many skeptics now believe in BIM.

Common BIM Requirements. (2012). Series 3.Arcitectural_design.

Common BIM Requirements. (2012). Series 1 General Part.

Common BIM Requirements. (2012). Series 1 General Part.

House, S. (April 6, 2015). Building Information Modeling: How the construction industry is getting 'smart'. *Popular Science*.

InfoComm_BIM_Taskforce_Brochure. (2015). Building Information Modelling. *InfoComm BIM Taskforce Brochure*, 11-12.

Jos Voskuil. (2013, December). The future of the Building Industry.

Julie Kyle. (2012_March). Many skeptics now believe in BIM . *Civil+Structural Engineer*.

magicad.com. (MagiCAD_for_Revit_HVAC&energy).

NCC.Projectia. (2014). *Projectia*. From http://projectia.ncc.fi

Olga Dashkova. (2015, april). BIM in practice.

OpenBIM, G. (2015). *www.graphisoft.com.* From http://www.graphisoft.com/archicad/open_bim/about_bim/

Reilyana, Y. (2015, february). TheMinistry_ofRussianFederation.

Sergey Veselov. (2015). NCC Chief project engineer, PhD .

The_Ministry_of_Construction_of_Russia. (2014). The_order. Moscow.

Vladimir Alexandrov. (2015). NCC project engineer .

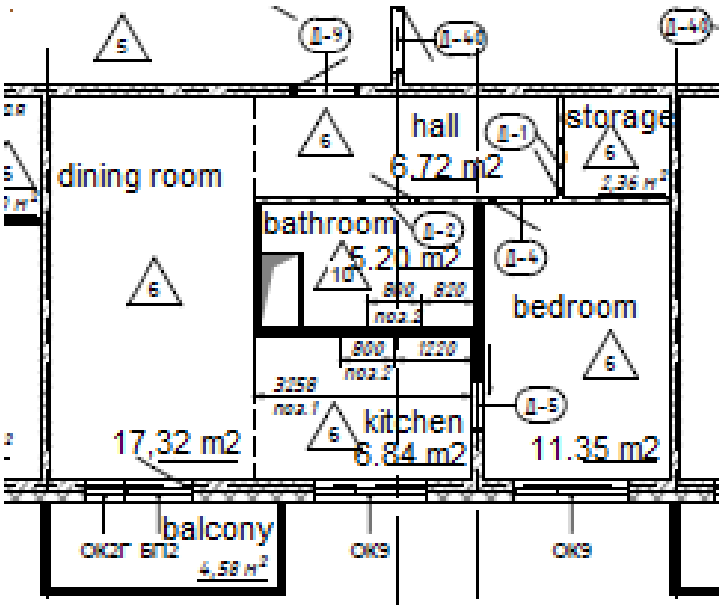
WorldCAD Access, V. T. (September, 2014). The State of BIM in Russia. *WorldCAD Access*.

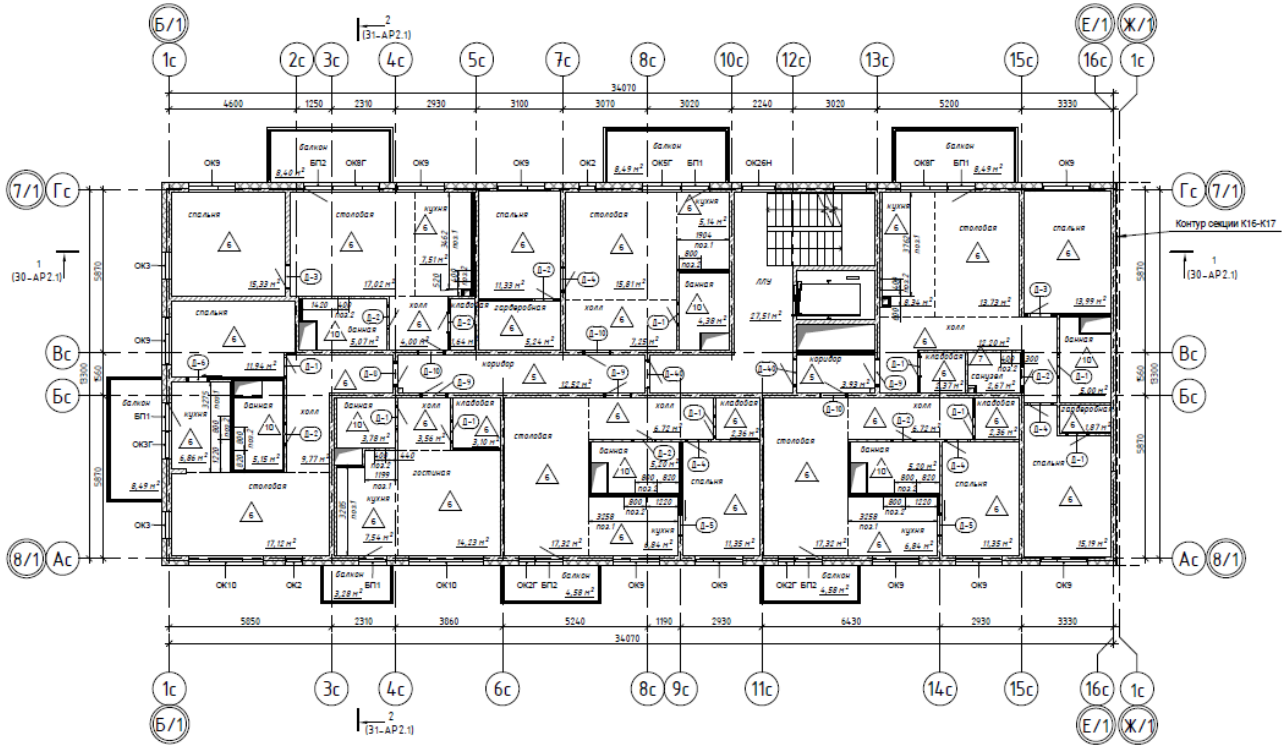
Appendix 1

Different plan drawings of K18 section of first construction phase:

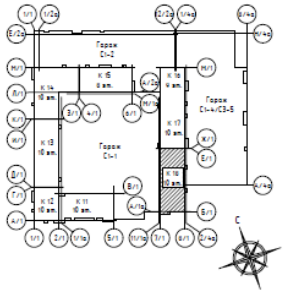
1. Typical flor plan
2. Demonstration material
3. Visual demonstration of solutions
4. Landscape visualization
5. Plan of Ventilation and Air conditioning
6. Plan of Water supplying
7. FRS plans (federal registration service)
8. Electricity Plan

1.






1 этап строительства
Схема компоновки корпусов




Примечание:
1. Данный лист смотреть совместно с листом 12 (АР2.1).
2. Спецификации заполнения оконных проемов см. лист 37 (АР0.1).
3. Спецификации заполнения дверных проемов см. лист 38 (АР0.1).
4. Экспликации полов см. лист 41 (АР0.1).
5. Детали усиления перегородок см. лист 34 (АР0.1). В плане размер и номер позиции указан со стороны установки фанерной закладной (со стороны крепления раковин и навесных шкафов).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 28011-000-24/13 | | | -АР2.1 |
| 1 | - | Зам. | 44-14 | | 15.12.14 | Санкт-Петербург. Петроградский район, Аптекарский проспект, д.16, лит.Б | | | |
| Изм. | Кол.уч. | Лист | №док. | Подпись | Дата | | | | |
| Ген.директор | | Первенов | | | 15.09.14 | Многоквартирный жилой комплекс с встроенно-пристроенным помещением, встроенно-пристроенным объектом дошкольного образования, встроенно-пристроенным подземным гаражом | Стадия | Лист | Листов |
| ГАП | | Макаренко | | | 15.09.14 | | Р | 13 | |
| Разработал | | Гуринова | | | 15.09.14 | План типового (9-10) этажа. Отделочный | Архитектурное бюро А2 | | |
| Проверил | | Первенов | | | 15.09.14 | | | | |
| Н.контроль | | Баранов | | | 15.09.14 | | | | |

Формат: А3А

Согласовано

Взам. инв. №

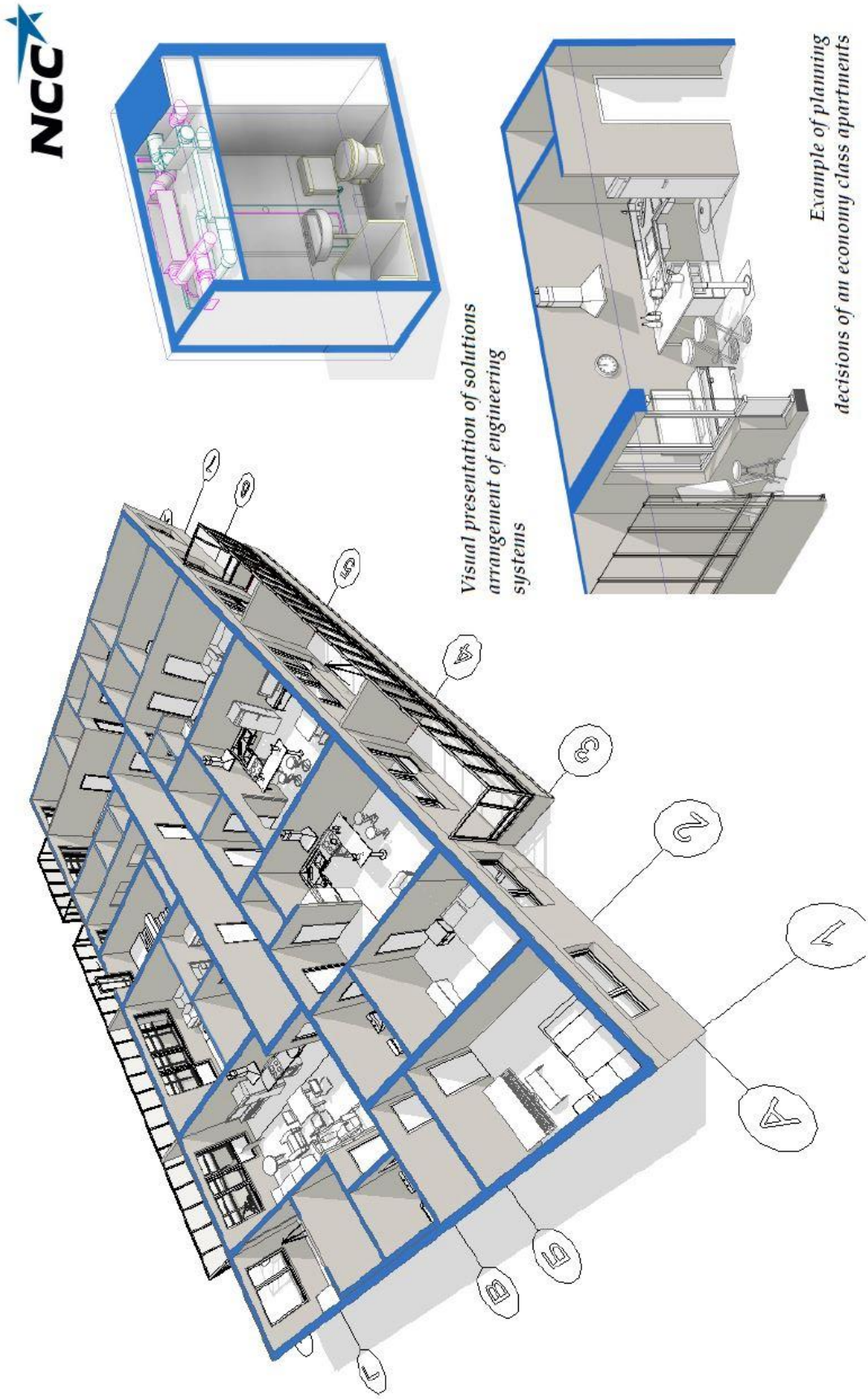
Подп. и дата

Инв. № подл.

2.

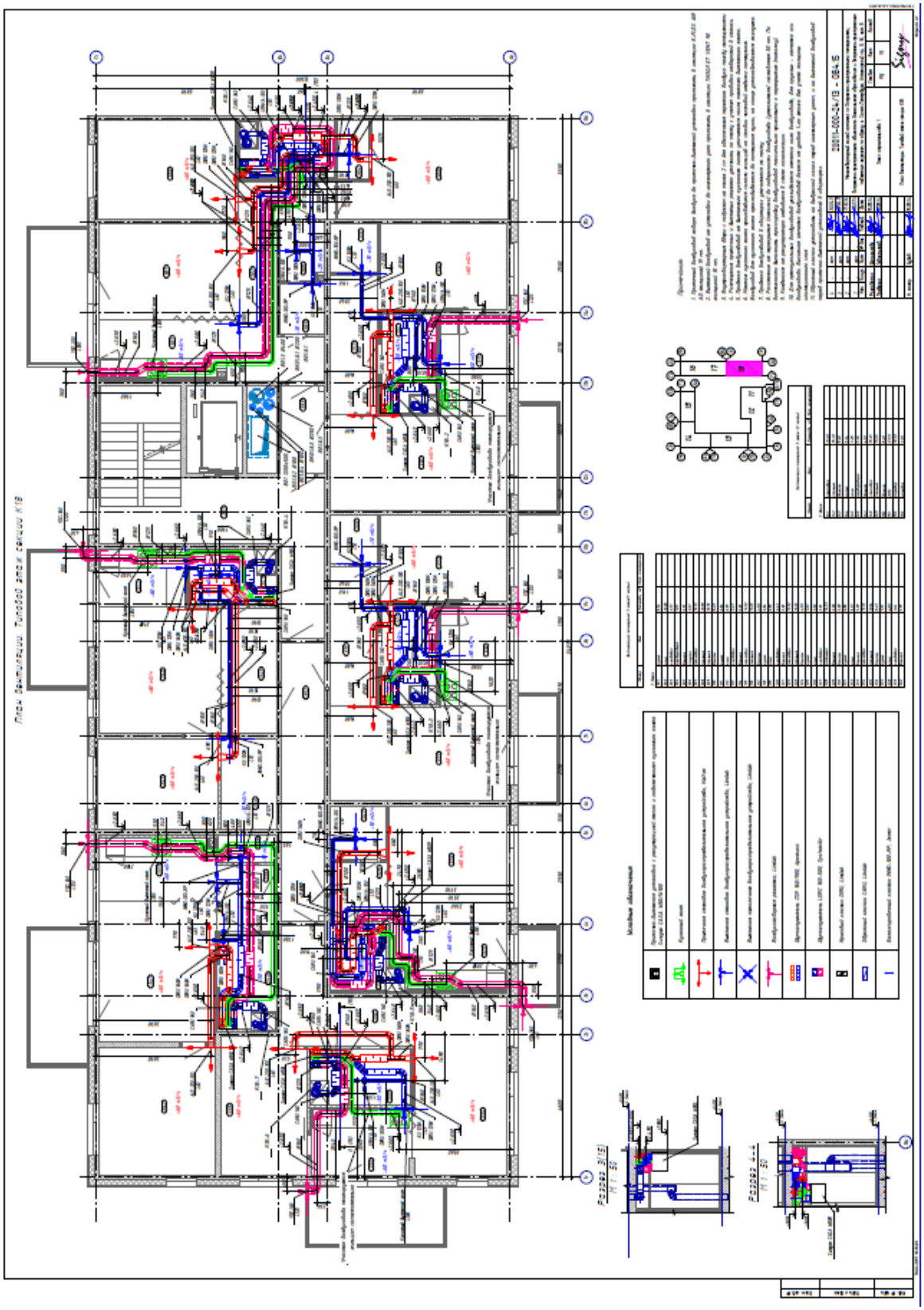

NCC
ПОЭТАЖНЫЙ ПЛАН. 1 ЭТАЖ
Пр. Медиков
Аптекарский пр.
ул. Академика Павлова
пр. Медиков
УСЛОВНЫЕ ОБОЗНАЧЕНИЯ
подземный паркинг
корпус
детский сад
супермаркет
несущие стены
перегородки
холодильник
плита
раковина
стиральная машина
ОДНОКОМНАТНАЯ КВАРТИРА
Skandi Klubb
клуб хороших соседей

3.

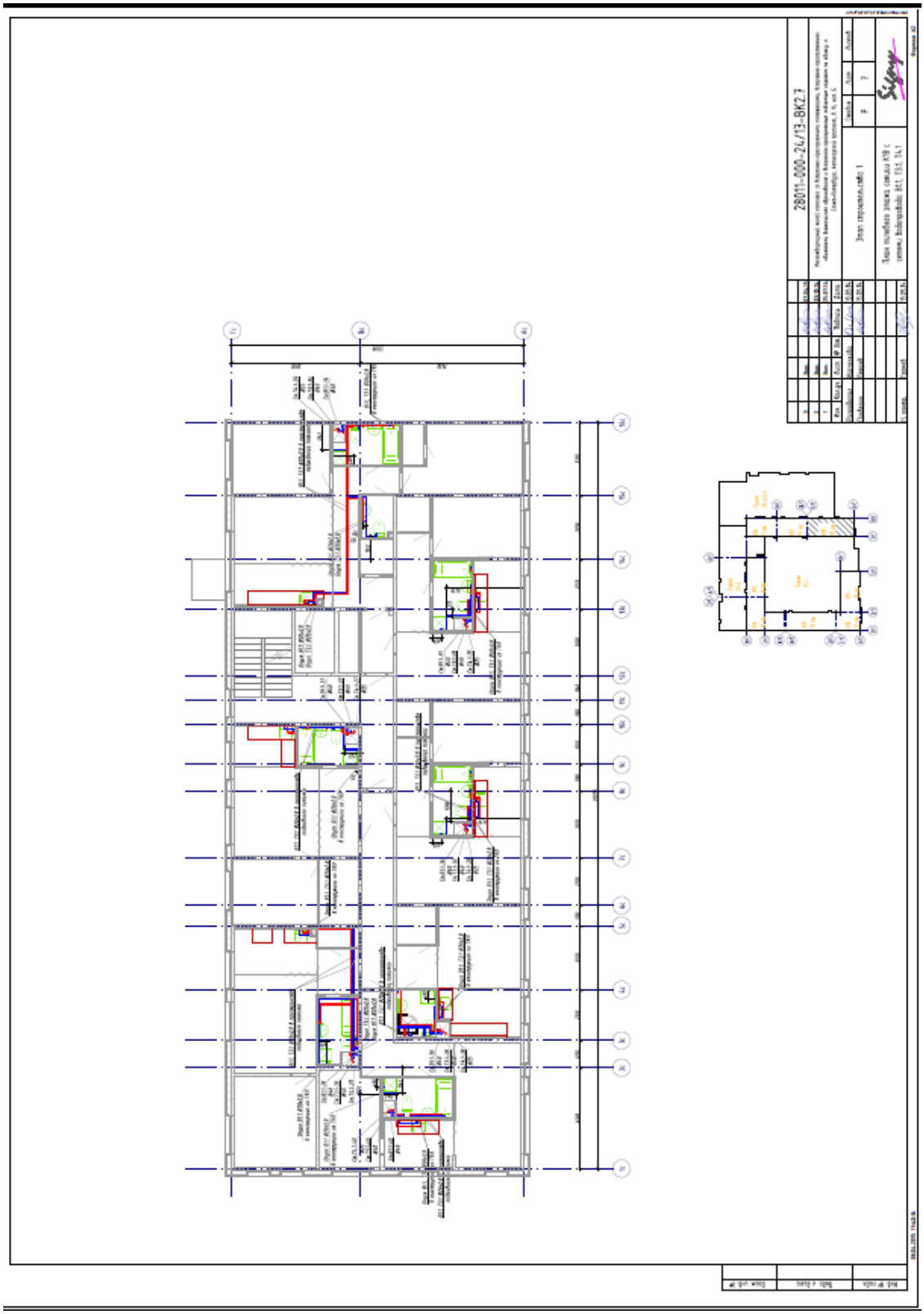

NCC
Visual presentation of solutions arrangement of engineering systems
Example of planning decisions of an economy class apartments

4.

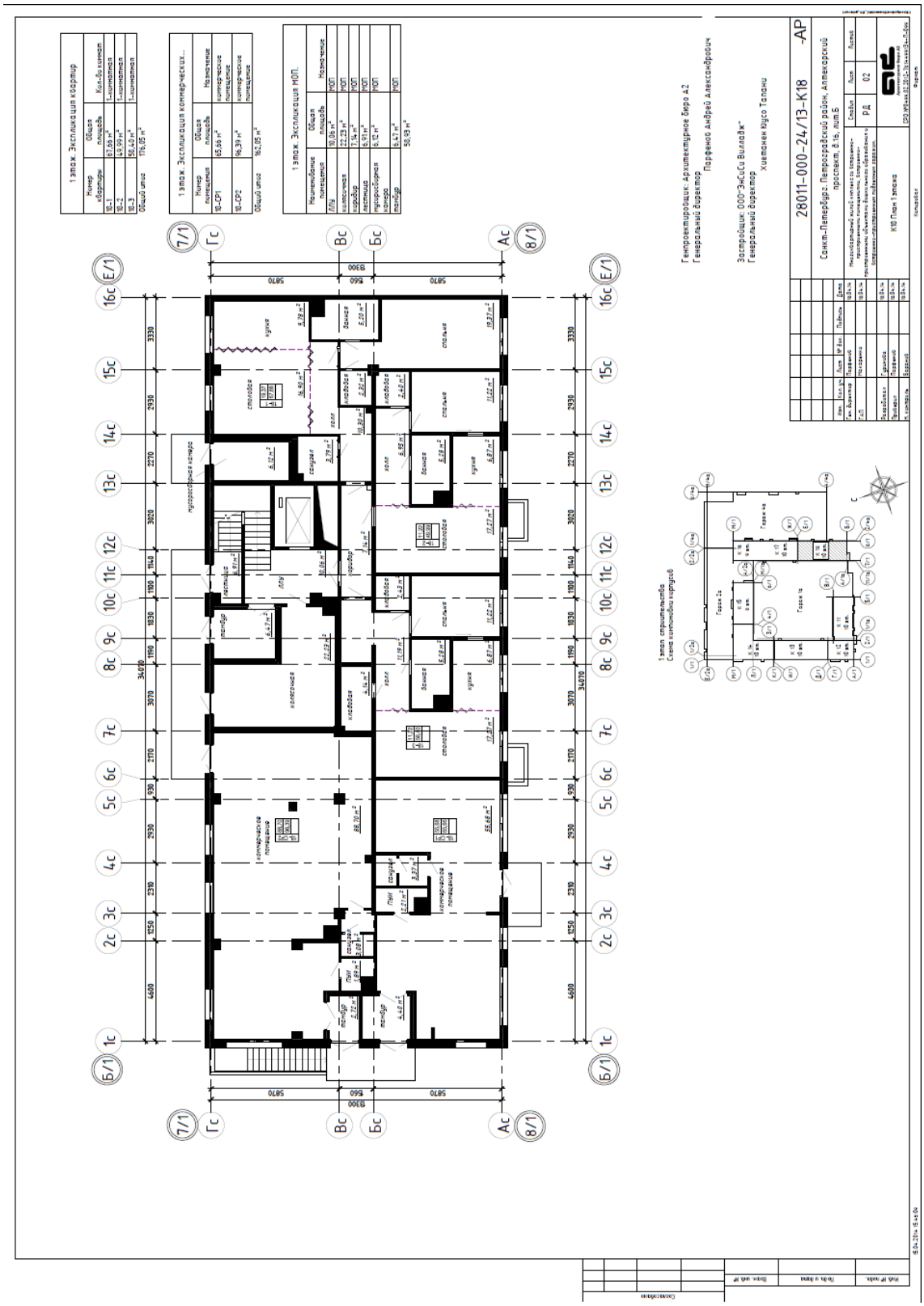
5.

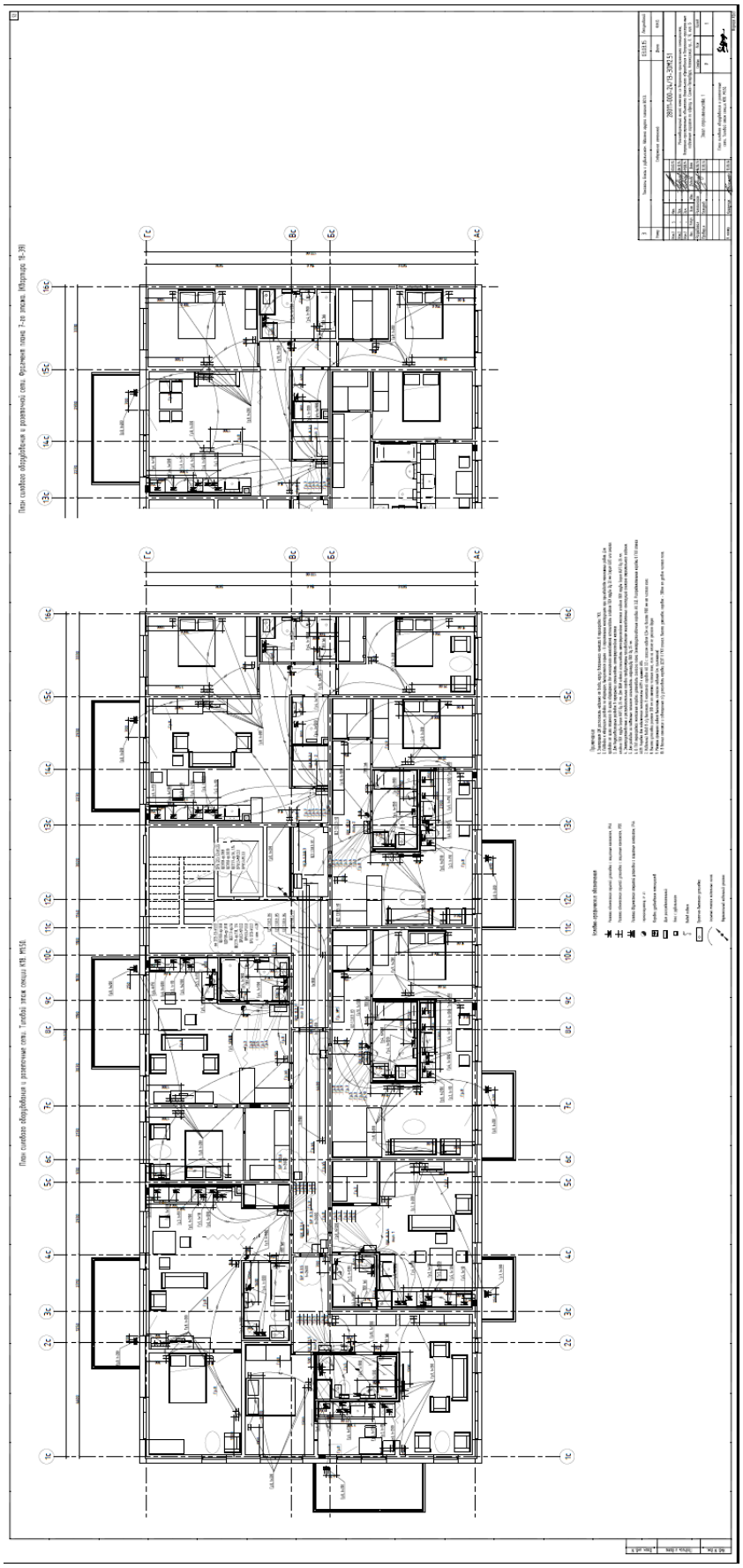


6.



7.


1 этаж. Экспликация квартир
Номер квартиры
Общая площадь
Кол-во комнат
1 этаж. Экспликация коммерческих...
Номер помещения
Общая площадь
Назначение
1 этаж. Экспликация МОП.
Наименование помещения
Общая площадь
Назначение
Генеральный директор
Генеральный директор
Генеральный директор
28011-000-24/13-К18
-АР
Санкт-Петербург, Петроградский район, Аптекарский проспект, д.16, лит.Б
Многоквартирный жилой комплекс со встроенно-пристроенными объектами вспомогательного назначения и подземной парковкой
Стадия
Лист
Листов
РД
02
К18 План 1 этажа
Копировал
Формат


План слаботочного оборудования и розеточной сети. Типовой этаж секции КОК МП1Б
План слаботочного оборудования и розеточной сети. Фрагмент плана 7-го этажа секции КОК группа 18-39
Условные обозначения
Примечания
2009.000-ЭС.ТХ-ЭОМ1.51

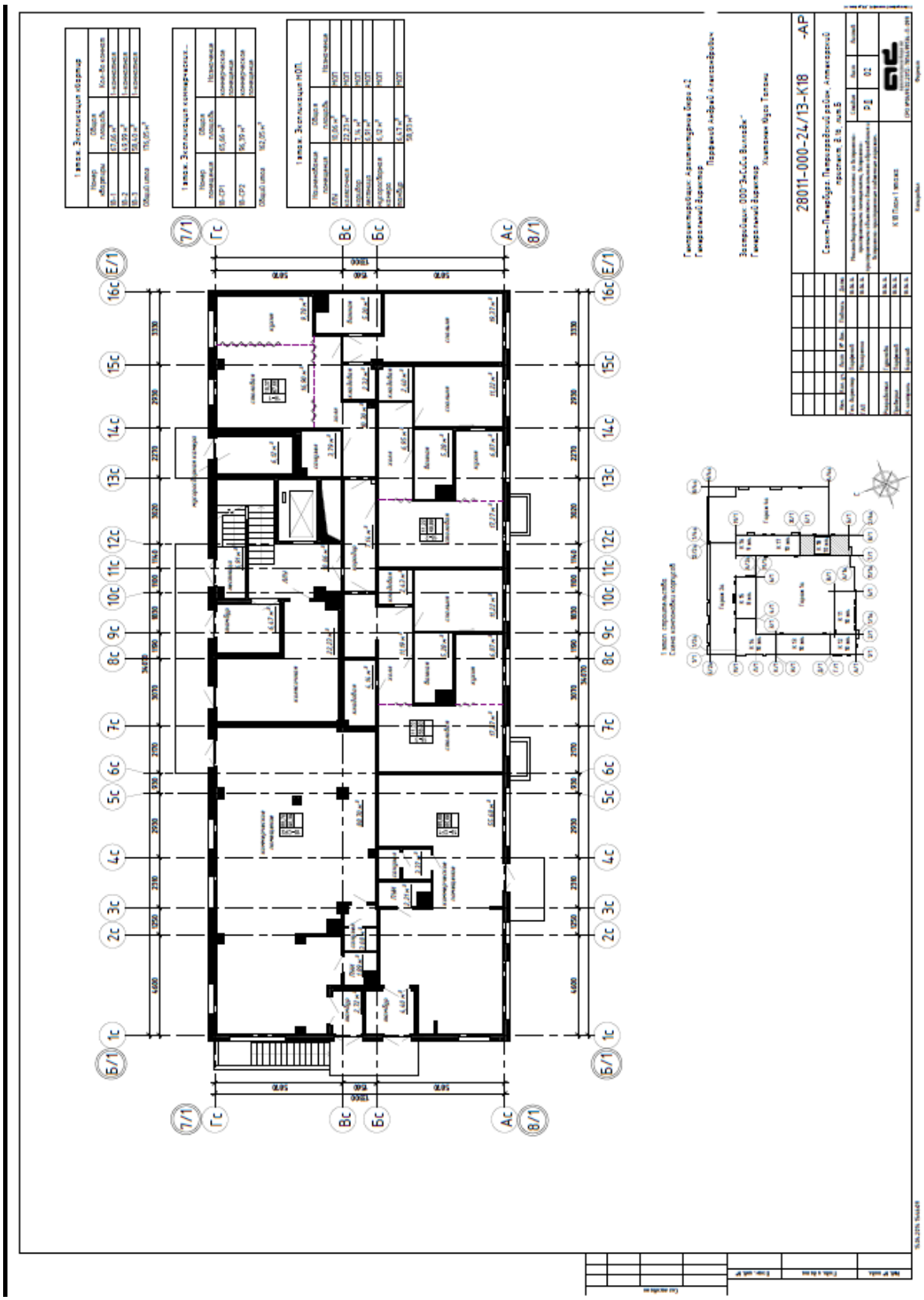
Appendix 2

3D-model of facades

Maquette of one of the flats

Appendix 3

Federal Registration Service Plan



Appendix 4

Common area model


-147
48
1

# Appendix 5

## Specification of the apartment rooms

### Спецификация помещений квартир К1

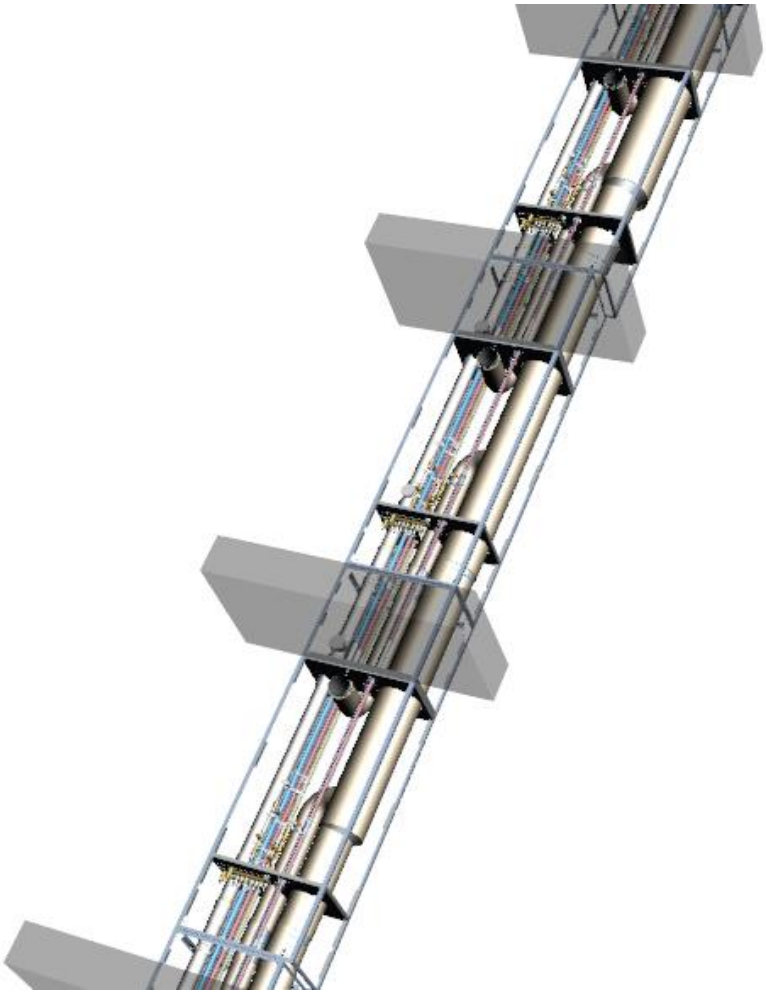
| | № секции | Уровень | № квартиры | Назначение | Жилая площадь | Площадь квартиры (без учета балконов и лоджий) | Общая площадь квартиры (с учетом приведенной площади балконов и лоджий) (коэф. автомат) | балкон 1 (коэф. автомат) | балкон 2 (коэф. автомат) | терраса (коэф. автомат) | Общая площадь квартиры (с учетом приведенной площади балконов и лоджий) | балкон 1 (без коэф.) | балкон 2 (без коэф.) | терраса (без коэф.) | ванная 1 | ванная 2 | гардеробная 1 | гардеробная 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 2 Этаж | 1 | 3-комнатная | 39,78 | 86,82 | 150,2 | | | 63,38 | | | | 126,76 | 5,24 | | | |
| 2 | | | 2 | 1-комнатная | 10,51 | 43,37 | 55,01 | | | 11,64 | | | | 23,28 | 5,21 | | | |
| 3 | | | 3 | 1-комнатная | 10,69 | 43,49 | 43,49 | | | | | | | | 5,35 | | | |
| 4 | | | 4 | 1-комнатная | 11,72 | 50,01 | 50,01 | | | | | | | | 5,25 | | | |
| 5 | | | 5 | 1-комнатная | 17,25 | 52,27 | 54,817 | 2,547 | | | | 8,49 | | | 4,75 | | | |
| 6 | | 3 Этаж | 6 | 3-комнатная | 39,78 | 86,82 | 89,097 | 2,277 | | | | 7,59 | | | 5,24 | | | |
| 7 | | | 7 | 1-комнатная | 10,51 | 43,37 | 46,121 | 2,751 | | | | 9,17 | | | 5,21 | | | |
| 8 | | | 8 | 1-комнатная | 10,69 | 43,49 | 46,412 | 2,922 | | | | 9,74 | | | 5,35 | | | |
| 9 | | | 9 | 1-комнатная | 11,72 | 50,01 | 52,287 | 2,277 | | | | 7,59 | | | 5,25 | | | |
| 10 | | | 10 | 1-комнатная | 17,25 | 52,27 | 54,67 | 2,4 | | | | 8 | | | 4,75 | | | |
| 11 | | 4 Этаж | 11 | 3-комнатная | 39,78 | 86,76 | 89,037 | 2,277 | | | | 7,59 | | | 5,18 | | | |
| 12 | | | 12 | 1-комнатная | 10,51 | 43,31 | 46,061 | 2,751 | | | | 9,17 | | | 5,21 | | | |
| 13 | | | 13 | 1-комнатная | 10,69 | 43,43 | 46,352 | 2,922 | | | | 9,74 | | | 5,29 | | | |
| 14 | | | 14 | 1-комнатная | 11,72 | 49,96 | 52,237 | 2,277 | | | | 7,59 | | | 5,2 | | | |
| 15 | | | 15 | 1-комнатная | 17,25 | 52,22 | 54,62 | 2,4 | | | | 8 | | | 4,7 | | | |
| 16 | | 5 Этаж | 16 | 3-комнатная | 39,78 | 86,73 | 89,007 | 2,277 | | | | 7,59 | | | 5,15 | | | |
| 17 | | | 17 | 1-комнатная | 10,51 | 43,28 | 46,031 | 2,751 | | | | 9,17 | | | 5,21 | | | |
| 18 | | | 18 | 1-комнатная | 10,69 | 43,39 | 46,312 | 2,922 | | | | 9,74 | | | 5,25 | | | |
| 19 | | | 19 | 1-комнатная | 11,72 | 49,92 | 52,197 | 2,277 | | | | 7,59 | | | 5,16 | | | |
| 20 | | | 20 | 1-комнатная | 17,25 | 52,18 | 54,58 | 2,4 | | | | 8 | | | 4,66 | | | |
| 21 | | 6 Этаж | 21 | 3-комнатная | 39,78 | 86,73 | 89,148 | 2,418 | | | | 8,06 | | | 5,15 | | | |
| 22 | | | 22 | 1-комнатная | 10,51 | 43,28 | 46,154 | 2,874 | | | | 9,58 | | | 5,21 | | | |
| 23 | | | 23 | 1-комнатная | 10,69 | 43,39 | 46,438 | 3,048 | | | | 10,16 | | | 5,25 | | | |
| 24 | | | 24 | 1-комнатная | 11,72 | 49,92 | 52,338 | 2,418 | | | | 8,06 | | | 5,16 | | | |
| 25 | | | 25 | 1-комнатная | 17,25 | 52,18 | 54,727 | 2,547 | | | | 8,49 | | | 4,66 | | | |
| 26 | | 7 Этаж | 26 | 3-комнатная | 39,78 | 86,68 | 89,098 | 2,418 | | | | 8,06 | | | 5,1 | | | |
| 27 | | | 27 | 1-комнатная | 10,51 | 43,23 | 46,104 | 2,874 | | | | 9,58 | | | 5,21 | | | |
| 28 | | | 28 | 1-комнатная | 10,69 | 43,34 | 46,388 | 3,048 | | | | 10,16 | | | 5,2 | | | |
| 29 | | | 29 | 1-комнатная | 11,72 | 49,87 | 52,288 | 2,418 | | | | 8,06 | | | 5,11 | | | |
| 30 | | | 30 | 1-комнатная | 17,25 | 52,14 | 54,687 | 2,547 | | | | 8,49 | | | 4,62 | | | |
| 31 | | 8 Этаж | 31 | 3-комнатная | 39,78 | 86,68 | 89,098 | 2,418 | | | | 8,06 | | | 5,1 | | | |
| 32 | | | 32 | 1-комнатная | 10,51 | 43,23 | 46,104 | 2,874 | | | | 9,58 | | | 5,21 | | | |
| 33 | | | 33 | 1-комнатная | 10,69 | 43,34 | 46,388 | 3,048 | | | | 10,16 | | | 5,2 | | | |
| 34 | | | 34 | 1-комнатная | 11,72 | 49,87 | 52,288 | 2,418 | | | | 8,06 | | | 5,11 | | | |
| 35 | | | 35 | 1-комнатная | 17,25 | 52,14 | 54,687 | 2,547 | | | | 8,49 | | | 4,62 | | | |
| 36 | | 9 Этаж | 36 | 3-комнатная | 39,78 | 86,62 | 89,038 | 2,418 | | | | 8,06 | | | 5,04 | | | |
| 37 | | | 37 | 1-комнатная | 10,51 | 43,23 | 46,104 | 2,874 | | | | 9,58 | | | 5,21 | | | |
| 38 | | | 38 | 1-комнатная | 10,69 | 43,34 | 46,388 | 3,048 | | | | 10,16 | | | 5,2 | | | |
| 39 | | | 39 | 1-комнатная | 11,72 | 49,87 | 52,288 | 2,418 | | | | 8,06 | | | 5,11 | | | |
| 40 | | | 40 | 1-комнатная | 17,25 | 52,14 | 54,687 | 2,547 | | | | 8,49 | | | 4,62 | | | |
| 41 | | 10 Этаж | 41 | 4-комнатная | 56,72 | 117,84 | 139,2 | 2,418 | | 18,942 | | 8,06 | | 63,14 | 5,49 | 3,78 | 3,4 | 3,08 |
| 42 | | | 43 | 2-комнатная | 31,76 | 69,89 | 81,254 | 2,547 | | 8,817 | | 8,49 | | 29,39 | 4,59 | | 1,99 | |

## Технико-экономические показат

| № | Наименование | Ед. изм. | Секции К11-К15 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | К11 | К12 | К13 | К14 | К15 | Итого | К16 |
| 1 | Площадь земельного участка (кад. №78:07:0003299:16) | га | - | - | - | - | - | - | - |
| | Коэффицент использования территории | га | - | - | - | - | - | - | - |
| 2 | Площадь участка в составе этапа строительства №1 | га | - | - | - | - | - | - | - |
| 3 | Площадь застройки, | кв. м. | - | - | - | - | - | - | - |
| 4 | Площадь покрытий, в т.ч.: | кв. м. | - | - | - | - | - | - | - |
| 4.1 | -асфальтовые проезды | кв. м. | - | - | - | - | - | - | - |
| 4.2 | -плиточное покрытие | кв. м. | - | - | - | - | - | - | - |
| 4.3 | -зеленые насаждения в т.ч.: | кв. м. | - | - | - | - | - | - | - |
| 4.4 | -укрепленный газон | кв. м. | - | - | - | - | - | - | - |
| 5 | Строительный объем здания, в т.ч.: | куб. м. | 14966,00 | 10215,00 | 18156,96 | 19238,61 | 11305,88 | 73882,45 | 10210, |
| 5.1 | -ниже 0.000 | куб. м. | 1769 | 1208 | 2450,2 | 2630,1 | 2006,7 | 10064,03 | 15 |
| 5.2 | -выше 0.000 | куб. м. | 13197 | 9007 | 15707 | 16608 | 9299,2 | 63818,42 | 87 |
| 6 | Кол-во этажей, в т.ч.: | шт. | 11 | 11 | 11 | 11 | 8+1 | 8+1, 10 | |
| 6.1 | -подземных | шт. | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5.2 | -надземных | шт. | 10 | 10 | 10 | 10 | 7+1 | 7+1, 10 | 9 |
| 7 | Этажность | шт. | 10 | 10 | 10 | 10 | 7+1 | 7+1, 10 | 9 |
| 8 | Общая площадь задния, в т.ч.: | кв. м. | 4272,20 | 2828,57 | 5168,42 | 5356,60 | 2945,18 | 20570,97 | 2678, |
| 8.1 | -ниже 0.000 | кв. м. | 357,19 | 236,56 | 413,86 | 441,84 | 319,62 | 1769,07 | 245, |
| 8.2 | -выше 0.000 | кв. м. | 3915,01 | 2592,01 | 4754,56 | 4914,76 | 2625,56 | 18801,90 | 2432, |
| 9 | Общая площадь квартир с учетом веранд, балконов, террас ( коэф. автомат.), в т.ч.: | кв. м. | 2593,4 | 1938,5 | 3573,7 | 3700,8 | 2132,1 | 13938,53 | 1907 |
| 9.1 | -жилая площадь | кв. м. | 808,08 | 740,77 | 1376,6 | 1501,4 | 886,12 | 5312,96 | 6 |
| 9.2 | -без учета веранд, балконов, террас | кв. м. | 2392,1 | 1875,4 | 3422,4 | 3569,3 | 2072,9 | 13331,96 | 1859 |
| 10 | Общая площадь встроенных помещений, в т.ч.: | кв. м. | 569,73 | 190,93 | 401,34 | 407,64 | 58,79 | 1628,43 | - |
| 10.1 | -супермаркет | кв. м. | 569,73 | 190,93 | 401,34 | 133,98 | - | 1295,98 | - |
| 10.2 | -коммерческие помещения | кв. м. | - | - | - | 273,66 | 58,79 | 332,45 | - |
| 11 | Общая площадь встроенных помещений 1-ого этажа общественного назначения, в т.ч.: | кв. м. | - | - | - | - | - | - | 94, |

Appendix 6

Engineering unit



Appendix 7

Model in the Solibri