Saimaa University of Applied Sciences
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Possibilities of VDC system for NCC Company

Bachelor's Thesis 2012

ABSTRACT
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Possibilities of VDC system for NCC Company, 60 pages
Saimaa University of Applied Sciences, Lappeenranta
Civil and Construction Engineering, Degree Programme
Bachelor's Thesis 2012
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The purpose of the thesis was to explore possibilities of VDC system. Nowadays it becomes more and more popular in the world to facilitate designer's work through using this system. This topic is actual because using this program is rare in Russia because of the underestimating. It could be useful to the project management for the preparation of construction drawings and documentation. The study is based on a building project that was drawn in 2D system. The thesis was written for the company NCC Construction in Russia, which is willing to be more efficient on the construction market.

To get any results it was necessary to have the program Autodesk Revit 2013. The trial version of program was downloaded and studied. There are plenty of print screens for making information clear for readers. The project management system in NCC Company was investigated and their needs in program options were also explored. During writing the thesis a lot of working information was used. The only problem was the lack of the equipment resources.

In the process of writing the thesis several advantages and disadvantages have been highlighted. The building project with drawings, specifications and terms of reference for designers are made as a result of this study, it can be applied as guidelines in further working of company.

Keywords: project management, specification, VDC system, Revit.

CONTENTS

1 INTRODUCTION

Using the project management system as a tool in Russia is just started compared to the experience of international companies, which have started to use the system in the middle of the last century. So it is a very short period.

In Russia as well as around the world local project management methodology is widespread. This methodology uses the framework of Project Management Institute standards.

The gap between the Russian and international practice of project management is about 15-20 years. Not only the methodology but also the computer software was developed during this time. A good example is Autodesk Revit program which is a Building Information Modeling software.

The target of this bachelor's thesis is to find out the benefits of using new software such as Autodesk Revit program and to show the final results in form of drawings and specification. The research is needed to improve the project management system in the company. The research contains the following steps:

1. To study the project management system in NCC Company.

2. To explore the possibility of using the program.

3. To create the example of using Autodesk Revit program in NCC Company.

The study is performed on one building in the residential complex NCC Village. The Model is designed by Building Information Modeling program – Autodesk Revit. Earlier this program has never been used in the company. The demo version of the program is used for the thesis.

2 HISTORY OF PROJECT MANAGEMENT

In the 1860s, in the United States, construction of transcontinental railroad was started. It was the impetus for making important decisions that became the basis for project management methodology. Suddenly, business leaders found themselves faced with the daunting task of organizing the manual labor of thousands of workers and the processing and assembly of unprecedented quantities of raw material.

Near the turn of the century, Frederick Taylor showed that labor can be analyzed and improved by focusing on its elementary parts that introduced the concept of working more efficiently, rather than working harder and longer.

In the 1910s Henry Gantt detailed the order of operations in work and is most famous for developing the Gantt chart. Gantt chart is a popular type of bar chart that illustrates a project schedule and has become a widely used method to represent the phases and activities of a project work breakdown structure, so they can be understood by a wide audience. Although now considered a general method for constructing graphs, Gantt charts were considered fairly revolutionary at the time they were introduced. Gantt charts were employed on major infrastructure projects including the Hoover Dam and the Interstate highway system and are still accepted today as an important tool in project.

Project management in its present form was introduced several years ago. In the early 1960s, industrial and business organizations began to understand the benefits of organizing work around projects. They understood the critical need to communicate and integrate work across multiple departments and professions.

In 1969 The Project Management Institute (PMI) was founded to satisfy the interest of the project management industry. Five volunteers established an organization where members could share their experiences in project management and discuss issues. Today, PMI is a non-profit project

management professional association and the most widely recognized organization in promoting project management best practices.

To help keep project management terms and concepts clear and consistent, PMI introduced the Project Management Body of Knowledge (PMBOK) Guide in 1987. They updated it in 1996, 2000, 2004, and most recently in 2009 as the fourth edition. At present, there are more than 1 million copies of the PMBOK Guide in circulation. (Barron, M.,& Barron, A., 2009).

3 PROJECT LIFE CYCLE

Any organization, group of people or person has different activities. It could be constant current operation to increase sales or production of products or services or to fulfill administrative functions.

A project is a temporary endeavor undertaken to create a unique product or service. Temporary means that every project has a definite beginning and a definite end. Unique means that the product or service is different in some distinguishing way from all similar products or services (PMBok, 2008).

There is a big difference between project, program and constant current operation. The last one has continuous, repeating, identical character which is linked to the calendar year, while the first one is unique, limited time and resources are determined and implemented a specific purpose at a particular time. Every project from beginning to end passes through certain stages or phases. Life cycle of project is a period of time between formalization of the idea and finishing of the project. (Funtov, 2011).

Figure 3.1 shows the usual cycle for project. The standard project always has four phases: initiation, planning, execution and closure.

Figure 3.1 Life cycle in project management

Initiation is a phase when the project objective or need is identified; an appropriate response to the need is determined. The major deliverables and the participating work groups are identified and the project team is started to form. Approval is then sought by the project manager to move on the detailed planning phase. (J. Westland, 2006).

Planning is the next phase. It is a phase, when project solution has further development. Necessary stages are being planned for review with the aim of the project. In this step a scope of works needed to be done is determined. A project plan is a description of activities, organization of chart, tasks, periods and analysis of possible risks. A project manager coordinates the preparation of a project budget. As the project team has identified the work, prepared the schedule and estimated the costs, the three fundamental components of the planning process are complete. This is the best time to determine and try to struggle with anything that might threaten the successful completion of the project. This is called risk management. This is also a good time to identify all project stakeholders, and to establish a communication plan describing the information needed and the delivery method to be used to keep the stakeholders informed. (J. Westland, 2006).

During the third phase, the execution phase, the project plan is put into motion and performs the work of the project. It is important to keep monitoring and reporting as required during execution. Progress is continuously monitored and

appropriate adjustments are made and recorded as a deviation from the original plan. During project execution, people are carrying out the tasks and progress information is being reported through regular team meetings. The project manager uses this information to maintain control over the direction of the project by measuring the performance of the project activities comparing the results with the project plan and takes corrective action as needed. The first course of action should always be to bring the project back on course, i.e., to return it to the original plan. If that cannot happen, the team should record variations from the original plan and record and publish modifications to the plan. Throughout this step, project sponsors and other key stakeholders should be kept informed of project status according to the agreed upon frequency and format. The plan should be updated and published on a regular basis. (J. Westland, 2006).

During the final closure, the emphasis is on production of the final results with the customer, transfer project documentation to the business, terminating supplier contracts, releasing project resources and communicating the closure of the project to all stakeholders. (J. Westland, 2006).

3.1 Project initiation

The first phase of project life cycle is initiating phase, which includes starting up a new project. During this phase business problems and opportunities are identified, project and team project is appointed to build and deliver the solution for customer. A business case is created to define the problem or opportunity in detail and identify a preferred solution for implementation. The business case includes a detailed description of the problem or opportunity, a list of the alternative solutions available, an analysis of the business benefits, costs, risks and issues, a description of the preferred solution and a summarized plan for implementation.

A manager of a company then endorses a business case, and allocates the necessary funding to begin a feasibility study. It depends on the company manager to determine if the project will be profitable to the organization.

The success of the project depends on the clarity and accuracy of the business case and people's belief in the possibility to achieve the project.

One of the biggest problems of this phase is misunderstanding among the project team and between customer and project team. If the project's objective is not identified clearly, the chances of problems and mistakes are increased. One of the best ways to gain approval for a project is to clearly identify the project's objectives and describe the need or problem for which the project will provide a solution. (Barron, M.,&Barron, A. 2009).

3.2 Project planning

The second phase of project life cycle begins after definition of a project and appointment of a project team.

Project planning is the heart of project life cycle. Within this phase plans are documented, the project deliverables and requirements are defined, and the project schedule is done. It contains creating a set of plans which will help through execution and closure phases of the project. The plans, which are done during this phase, will help you to manage time, cost, quality, changes, risk and related issues. It will also help you manage project team and external suppliers, to ensure that you deliver the project on time.

The purpose of the project planning phase is to make ready: business requirements, cost calculations, a schedule, procurement plan, a resource plan. A result of this phase is an approval of management, then a project moves to the next stage.

The basic processes of project planning are scope of work definition, scope planning, preparing the work breakdown, project schedule development, resource planning, budget planning, procurement planning, risk management planning, quality planning, and communication planning.

The planning phase refines the project's objectives gathered during the initiation. Now that these objectives have been recognized, they must be clearly

articulated. This articulation serves as the basis for the development of requirements. (J. Green and A. Stellman, 2007).

3.3 Project execution

After planning phase the project execution phase could be started, the third phase of the project management life cycle. The execution phase is to put the project plan into action. At this stage the project manager will coordinate and manage project resources to meet the objectives of the project plan. As the project unfolds, it is the project manager's job to direct and manage each activity on the project, every step of the way. That is what happens in the execution phase of the project lifecycle; it needs simply follow the plan and handle any problems that come up. (Barron, M., &Barron, A. 2009).

3.4 Project closure

Every project needs to be ended and that is what project closure is all about in the last phase of the project lifecycle. It is a process of acceptance of the product. It is needed to make sure that all stakeholders are satisfied and all acceptance criteria are met. Once that happens, the project can finish.

Project closing is often the most often neglected phase of the whole project lifecycle. Construction projects have a clear regulation acceptance commission, a list of relevant documents, and a description of the procedures. The key activity in project closure is gathering of project records and distributing information to formalize acceptance of the product, service or project as well as to perform project closure. The project information collected during this phase should reflect the characteristics and specifications of the final product. Some team members will have come and gone over the course of the project; it needs to be double-checked that all the resources and their roles and responsibilities are noted. Once the project outcomes are documented, it will request formal acceptance from the stakeholders or customer. (Barron, M., &Barron, A. 2009).

4 PROJECT LIFE CYCLE IN NCC COMPANY

Construction project life cycle has some changes. It consists of a tender phase, a contract phase, a general planning phase and implementation, commissioning phase. (Hannu Koski, 1995)

The NCC Company services as a main contractor and developer. NCC Company is divided into two branches: Real Estate NCC Company and Construction NCC Company. NCC Construction has only one client – NCC Real Estate. That is why tender phase is not relevant for Construction Department. The project starts with a contract between NCC Real Estate and NCC Construction. Construction Department services a role of a main contractor (general contractor) and concludes agreement within other contractors (subcontractors), which are implementing particular works.

After signing of the contract the general planning phase begins. Within this phase special plans are worked out and detailed. The last phase is implementation and production planning during construction. It should be controlled and monitored to make sure that the objectives are met and the project will be completed within time and resource limitations.

4.1 General planning phase

NCC Real Estate searches the land for construction and elaborates the technical design assignment based on location, area and other details of future building. Real Estate Department is main contractor; it employs a designing agency and manages the project design.

Revenue forecast, cash receipts, expenditures and payments for items is made at the design stage. Approved budget is the main financial document of the project, based on its resources. (Беляева, 2011).

After drafting the project is examined and the contract could be signed. Then start-up meeting is held. Here the contract, work divisions in the planning phase

and site organization are discussed. The site organization is established and, therefore, the persons responsible for work planning, preparation of budgetary objectives and initiating construction activity are chosen. The discussions also deal with project schedules, control periods and project reporting. Construction techniques and resources have to be selected before preparing time and resource plans. In order to serve work and management purposes, several special plans are considered. An important part of general planning is the establishment of the budgetary objectives, for which the cost estimations are base information. When commencing work on site, various supplies, contracts and announcements have to be arranged. (Hannu Koski, 1995).

In NCC Company each item is done by own Software, for example, general schedule in PlaNet+6.3; drawings in AutoCAD; procurement plan in Excel Microsoft Office; cost estimation in CMPro.

4.2 Implementation phase

Implementation phase for project management could be called production phase. There is a group of processes in this phase. They are quality control; set of the project team; development of the project team; management of the project team; information distribution; managing expectations of stakeholders; implementation of procurement. For these items it needs site plan, schedules, weekly planning, special plans, meetings and negotiations. Site plan has to be new for each construction phase. It indicates the location of buildings, storage areas, equipment, roads and other facilities for the work-force during construction phase. Schedules on this phase are more accurate than the general schedule. Weekly planning is necessary for detailing the construction phase schedules. There are meetings for discussing issues concerning the schedule. Monitoring and control have to be done during implementation phase: comparison of the current course of execution with the plan, evaluation of the implementation, analysis and response to risks.

4.3 Commissioning phase

Finishing operation and project evaluation need to be done at last. Finishing operation has three stages: handing over; termination and reinstatement works, and assessing the project's overall performance. For the commissioning phase there should be a formal procedure which is followed by proper documentation.

At the end of the project the following action could be take place: acceptance by the customer, analysis of the project, documentation of accumulated knowledge, archiving all important documents of the project, closing purchases.

5 THE MORE DETAILED PLAN OF HOUSING DEVELOPMENT IN NCC COMPANY

5.1 Plot Acquisition

Plot Acquisition has four stages: Plot Market Analysis, Plot Acquisition Proposal, Acquisition and Customer.

5.1.1 Plot market analysis

Plot market analysis consists of monitoring of current situation in the market of land resources (projects), collection and archiving of information. Based on the collected data, a preliminary analysis of received proposals for plot (project) acquisition is made. The incoming proposals are archived and evaluated in accordance with the company regulations (procedures). Preliminary analysis results in taking decision of further plot (project) consideration. (http://projectia2.ncc.fi).

5.1.2 Plot Acquisition Proposal

Preparing acquisition proposal requires obtaining detailed plot information from potential contracting party. When possible, this information is checked and confirmed against own company surveys. Required negotiations are held, resulting in the prepared proposal (investment memo) for internal investment decision.

5.1.3 Acquisition

Investment is made by signing a binding agreement according to the terms and conditions of the investment memo. Land can also be controlled by an option contract. The agreement is filed by BU Controller or appointed person in the BU. At this point development costs can start to be activated.
The following items have to be checked in making a contract:
1. Can the investment be made according to the terms and conditions of the investment memo?
2. Can an option contract be signed giving control of the property?
Contracts and other legal documents necessary for vesting the rights for the plot have to be prepared and the set of documents is then submitted to the authorized institutions for registration. After studying request, authorized institutions issue documents confirming registration of rights. (http://projectia2.ncc.fi).

5.1.4 Preliminary definition of customer demands

When planning the acquisition of a land area or plot, a suitable customer segment and a suitable product is designated for it in support of the acquisition decision at the given location. This ensures that the intended acquisition is easily transferable into an NCC Housing project or Housing Partnering project which meets both the financial business targets and targets for customer satisfaction.

5.2 Town Planning

Today the urban planning should take into account a range of complex economic, social and environmental issues. There are four steps for Town Planning: Data Collection for Town Planning, Town Planning and Customer.

5.2.1 Elaboration of town-planning documentation

At the early development stage, standard town-planning documentation to be collected and analyzed consists of:

- General town plan (GP, ГП);
- Land use and development rules (PZZ, ПЗЗ).

If the above documents are missing in approved form, their drafts are to be considered. On the ground of received materials, the following documents are to be elaborated:

- Town planning documentation (PPT, ППТ).

5.2.2 Reserving rights to town planning documentation

The company submits an application to the authorized governmental agency, requesting a permit for town planning (PPT) elaboration. The administration can act as PPT customer or delegate this right to the investor (administration still keeps controlling PPT elaboration). Reserving of rights to PPT elaboration is an official order document (enactment, order) of the authorized governmental agency.

5.2.3 Pre-marketing on the Internet

The project is included and displayed on NCC web pages in section "preliminary marketing" after the preliminary marketing has started and after those included in the customer register have received a notice on the project's preliminary marketing.(http://projectia2.ncc.fi).

At this point the page includes a brief description of the project and the area, housing type, address and designer data and, possibly, the preliminary moving-in date. Examples of apartment types available and prices can be displayed on

the page, including a link to the complete list of apartments. In this phase the customers can order brochures or download them in pdf form. In addition to the information stated above, the page must contain contact data of the sales and salespersons and pictures of the upcoming project. Project-specific www pages can also be prepared on the project, e.g. westpark.ncc.fi, if the project or the area is a major one or otherwise significant. Project-specific www pages are procured from an outside company and a separate process shall be observed in their preparation.

5.3 Management of Utilities

Management of Utilities has three phases: Technical Conditions for Utilities, Design Utilities and Construction of Utilities. Utilities are complex systems and communications. The main purpose of utilities is to ensure the life of the population, household services, organizations, social purpose.

Utilities are an essential element of any building. During construction of the new building design engineering services is a very important step. It requires special skills and deep knowledge in the field. Engineering networks implies a coordination of many factors in a variety of areas. Engineering networks based on an assessment of the feasibility of accommodation, the analysis of technical ability, as well as compliance with safety requirements.

5.3.1 Utilities management

Utilities are the facilities of engineering infrastructure, built on the ground of technical conditions received from regional monopolists.

Utilities include power lines, water supply systems and sewages, heat supply systems and other facilities, construction of which is required by issued technical conditions. Utilities can also include the facilities not directly required by technical conditions but necessary for engineering.

Ready utilities, built in accordance with issued technical conditions, are handed over by transferring them from NCC books to the books of the entities which are appointed to run and maintain utilities.

5.3.2 Designing

Based on the obtained technical conditions and conducted bidding, NCC signs contracts for work designs of utilities with licensed design organizations. Work designs are developed according to standards and rules for design, as well as to the NCC's technical task, and are approved by all agencies concerned. Developed and approved in full, designs are then transferred to organizations which participate in construction tenders, for cost evaluation. Data is recorded in offer comparison table; bidding documentation is prepared. (http://projectia2.ncc.fi).

5.3.3 Construction of utilities

Utilities are constructed based on technical conditions received from monopolists. Two ways of utilities construction can be used:

1. Construction under the monetary contract with monopolist.

Utilities for the project are constructed under monetary contract with engineering agency (the monopolist) which has issued these technical conditions. The contract defines construction terms and payment schedule.

2. Construction under the property contract or monetary-property contract.

Utilities for the project are constructed under the contracting agreement signed with licensed organization at NCC's choice, on the ground of issued technical conditions.

When constructing according to option 1, the monopolist supervises construction and also checks conformity of works in progress with issued technical conditions.

When constructing according to option 2, both the monopolist and the NCC as the customer supervise construction.

5.4 Design

Design involves defining the object location on the plot, style and conceptual space planning solutions, the main technical and economic indicators as well as creation and approval of working. Technical Task for Design, Project Development, Working Documentation and Customer are the steps for Design stage.

5.4.1 Collection and submission of the initial data for design

In accordance with the Russian legislation, Task for Design (Задание на проектирование) 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. (http://projectia2.ncc.fi).

«Register of initial data» is an integral appendix to each design contract. Normally, initial data are divided into two parts for process acceleration: (1) initial data necessary for development of design documentation and (2) initial data necessary for seeking approvals and passing the State Expertise. The register of initial data shall not only be adapted to the particular project, but also be corrected with regard to project location (Saint-Petersburg, the Leningrad Region, etc.), since requirements to initial data and set of required approvals may vary depending on the region.

5.4.2 Preparation of Project Stage design

Project Stage, also known as Stage P (стадия «Проект», стадия П), 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 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.

5.4.3 Preparation of Working Documentation

Prior to preparation of Working Documentation (WD, Рабочая документация), NCC must give designers a Task for Working Documentation (Задание на рабочую документацию) 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 required adjusting surveys, working actively with monopolists and approving agencies, helping designers find 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 set of Working Documentation in agreed number of copies, which hereafter is transferred to the General Contractor, bearing a stamp «released for construction». (http://projectia2.ncc.fi).

5.4.4 Sales regulation

Sales regulation is a special document describing the work of the Sales department and its communication with other departments of the company. Sales regulation is approved by the general director.
Sales regulation describes:

- Sales department commitment in Design stage
- Sales process
- Customer care process
- Reporting
- Commissioning process
- Sales commitment in Advertising
- Archiving
- Education

5.5 Preparation of Production

Preparation of Production stage is divided into Basic Plans of Production, Management, Purchasing Plan, Finance, Safety Plan and Customer phases.

5.5.1 Project Plan for Construction

A Project Plan is prepared for each project implemented by NCC. A project plan describes how the procedures included in the company's Management System are adopted to the given project. The plan describes the basic planning, implementation and control procedures related to management, the environment and site safety in a concrete project.
The Project Plan defines all plans and procedures which allow to reach the targets set for the project. The preparation of this plan is based on the requirements defined by the customer in the contract, the company’s own operating policies and the project’s identified risks.
The preparation and implementation of a Project Plan is the responsibility of the appointed project management. A ready-prepared Project Plan is approved with

the customer and the profit unit management. Approval by the profit unit management serves as the permission to start production. (http://projectia2.ncc.fi).

5.5.2 Management

The targets concerning site personnel are defined in every project separately. Project-level targets are based on the target estimate, as well as corporate-level indicators which are considered at the making of a project's result action plan. A project result action plan defines:

- key results of the project
- key targets set for the project
- means of achieving the targets

In addition, a target estimate is set for the project in the project monitoring system.

At the result appraisal and development discussions, the superior and the person in charge agree jointly on the personal targets of the person in charge, including demands for development and training based on the charting of competence.Project monitoring and forecasting is done on a monthly basis. These are considered at the project monitoring meetings.

The result is measured on corporate, profit unit and project levels. The aspects to be measured are financial matters, efficiency, personnel, customer, safety, quality and environmental matters. The bonus pay of project personnel is defined based on both financial and functional indicators.

Site post-completion analysis is made to give an appraisal on the successes and failures of the newly-completed project. The purpose of making a post-performance appraisal of suppliers and subcontractors is to collect feedback data on the quality-producing ability of used suppliers. The making of a post-completion analysis and post-performance appraisals is the responsibility of the site management. Post-completion analyses are saved in the company's common post-completion analysis bank. (http://projectia2.ncc.fi).

5.5.3 Purchasing plan and its updating

A purchasing plan is a tool for planning and supervision of project purchases which is based on the site master schedule. A purchasing plan presents the major purchases of a project. Responsible for implementing the purchase plan is site management.
The purchasing plan is prepared prior to commencing the project.

A standard purchasing plan form is used throughout NCC which presents the following information by the purchasing packages:
- Quantities
- Target cost
- Deadlines for designs
- Preparation of task plans purchase-by-purchase Y/N
- Deadlines for posting offer requests
- Time schedule for deliveries
- Purchasing lots purchase-by-purchase
- Responsible person purchase-by-purchase

In addition, the supplier's name and contact data must be presented in the purchasing plan, when it is known. The purchasing plan defines the demands for drawings and deadlines for their delivery. The purchasing plan must be compatible with the site drawing schedule.
The purchasing plan is updated as required:
- To correspond to the purchasing decisions made (e. g. supplier data)
- Upon changes made to the purchasing lots
- According to any changes in the site time schedule.

5.4.4 Financial site administration

Financial site administration means all procedures to ensure the final financial result targeted for the project.

The estimates and forecasts of separate projects are summarized at first in the units' profit estimates and, following this, in the entire company's profit

estimates. When the financial indicators are correct and provided on time, problem areas can be settled earlier and the projects and the company steered to the right direction. (http://projectia2.ncc.fi).

5.4.5 Site safety planning

Site safety planning starts with a charting of site safety risks, which involves identification of risks related to the site implementation and preparation of preventive measures for them. A safety document prepared by the employer is used in support of site safety planning.A health and safety officer is appointed in the project plan for each site to implement the agreed inspections under the supervision of the site management. The site safety organization is always prepared considering authorities' and client's demands.

To guarantee general site safety and prevent upcoming risks, safety inspections are held at the site on a regular basis throughout the construction period. Inspections provided by law are divided into two main groups: inspections held at taking into use and regular in-service inspections.
Most site safety factors are related to the particular work phases. Therefore, site safety matters must be verified at the work planning. Identified safety requirements are considered at the start-up meeting of the respective work phase and their fulfillment is controlled by site safety inspections and quality control measures of the work phase. (http://projectia2.ncc.fi).

5.4.6 Kick-off meeting of sales

The purpose of the kick-off meeting of sales is to provide the selling team with all such financial and administrative information as will be required in the project selling process.
A meeting is arranged in two weeks before the official sales start.
The meeting is convened by the Head of the Sales department. Persons who have essentially contributed to the compilation of the project should participate (project manager, development team representative, lawyer, representative from the financial department, marketing specialist).

- Project manager presents the project schedule, a list of the possible changes for alteration works and a schedule for those
- Development team is responsible for the building permit, design documentation
- Lawyers are responsible for the agreements, power of attorney templates
- Head of sales department presents the sales scheme and customer care process
- Financial department is responsible for the payment scheme and reporting forms approval.
- Marketing department checks the need of marketing materials changes to be made due to the changes in design for example and to know the latest project schedule.

This will ensure that everybody has project materials with identical contents when launching the sales.

The meeting agenda is always the same and the minutes of the meeting shall be kept.

5.6 Production

The Production stage has Designer's Supervision step, Scheduling, Management, Finance and Procurement step, Continues Task Supervision and the step of Safety and Customer.

5.6.1 Author supervision

Author supervision is an abiding procedure, following the project construction from its start to completion (putting into operation). It consists of monitoring of civil works conformity with approved design documentation.

If necessary, the permissible alterations can be introduced in engineering deliverables of the design and construction project as a part of architectural supervision.

Permissible alterations - changes which do not entail violations in constructive, architectural and engineering solutions used in the project and have passed through expertise. These changes can be introduced according either to the company's will or to the client's wish in case if the company adopts program of possible changes of the project. In case when possible changes entail necessity of additional (recurrent) expertise, decision about their realization is taken individually. (http://projectia2.ncc.fi).

Author supervision is implemented by a licensed design organization (organizations). The organization responsible for author supervision is selected at the project designing stage (stage D). The design organization implements author supervision either within the framework of general design contract, or a separate contract is concluded. The contract and current specification documents define the order of author supervision.

Author supervision is implemented in accordance with the contract concluded, current specification documents. Under the concluded contract and current specification documents the architectural supervision term, scheduled and unscheduled periodicity (construction site visit by the organization representative), order of recording necessary changes in architectural supervision log, order of waiving alterations in design documentation. A representative of author supervision organization is obliged to visit the construction site in due time, to make necessary notes in author supervision log book.

It needs to go by the provisions of concluded contract and current specification documents if the unscheduled construction site visit is necessary (on customer request).

The organization responsible for author supervision is obliged within its powers to prepare the required set of documents for putting the project into operation.

The responsible representative of author supervision organization shall present at events under procedure of putting the project into operation by signing the necessary documentation.

5.6.2 Drawing Schedule and Supervision

A drawing schedule is a project management tool which indicates the demands and times for issuing building plans to the employer and designers. The project manager of design is responsible for implementing and updating this document.

The purpose of preparing a drawing schedule is to manage the receipt of the necessary, missing and supplementary designs at the commencement and during the site, which ensures undisturbed execution of works. (http://projectia2.ncc.fi).

The drawing schedule is considered and officially approved at the first site meeting. Thus, the client undertakes to deliver the necessary designs according to the schedule. The realization of the drawing schedule is monitored and it is complemented as the work progresses.

The drawing schedule is related to other general planning so that the preliminary master schedule must be completed before it is prepared. At the same time a procurement plan is made which serves as the basis for defining the most critical points of the drawing schedule.

The drawing reception and distribution procedure allows to monitor the completion of designs, to ensure the discovery of changes and revisions as well as their communication to the production.

The site responsible person is responsible for ensuring that the site always has the latest document versions and that outdated versions are identified and removed from use.

The latest drawing list is a document of new and outdated documents. Any changes in a document as well as the date of the change are recorded on the document cover sheet.

5.6.3 Management

The targets concerning site personnel are defined in every project separately. Project-level targets are based on the target estimate, as well as corporate-level indicators which are considered at the making of a project's result action plan. A project result action plan defines:

- key results of the project
- key targets set for the project
- means of achieving the targets

In addition, a target estimate is set for the project in the project monitoring system. (http://projectia2.ncc.fi).

At the result appraisal and development discussions, the superior and the person in charge agree jointly on the personal targets of the person in charge, including demands for development and training based on the charting of competence.

Project monitoring and forecasting is done on a monthly basis. These are considered at the project monitoring meetings.The result is measured on corporate, profit unit and project levels. The aspects to be measured are financial matters, efficiency, personnel, customer, safety, quality and environmental matters. The bonus pay of project personnel is defined based on both financial and functional indicators.

A site post-completion analysis is made to give an appraisal on the successes and failures of the newly-completed project. The purpose of making a post-performance appraisal of suppliers and subcontractors is to collect feedback data on the quality-producing ability of used suppliers. The making of a post-completion analysis and post-performance appraisals is the responsibility of the site management. Post-completion analyses are saved in the company's common post-completion analysis bank.

5.6.4 Financial site administration

Financial site administration means all procedures to ensure the final financial result targeted for the project.

The estimates and forecasts of separate projects are summarized at first in the units' profit estimates and, following this, in the entire company's profit estimates. When the financial indicators are correct and provided on time, problem areas can be settled earlier and the projects and the company steered to the right direction. (http://projectia2.ncc.fi).

5.6.5 Purchasing plan and its updating

A purchasing plan is a tool for planning and supervision of project purchases which is based on the site master schedule. A purchasing plan presents the major purchases of a project. Site management is responsible for implementation purchase plan.

The purchasing plan is prepared prior to commencing the project.

A standard purchasing plan form is used throughout NCC which presents the following information by the purchasing packages:

- Quantities
- Target cost
- Deadlines for designs
- Preparation of task plans purchase-by-purchase Y/N
- Deadlines for posting offer requests
- Time schedule for deliveries
- Purchasing lots purchase-by-purchase
- Responsible person purchase-by-purchase

In addition, the supplier's name and contact data must be presented in the purchasing plan, when it is known. The purchasing plan defines the demands for drawings and deadlines for their delivery. The purchasing plan must be compatible with the site drawing schedule.

The purchasing plan is updated as required:

- To correspond to the purchasing decisions made (e. g. supplier data)
- Upon changes made to the purchasing lots
- According to any changes in the site time schedule

5.6.6 Quality Assurance matrix of task entity

With the aid of a site quality assurance matrix adequate quality planning, supervision, control and verification to be directed at the site work entities / subcontracts is ensured. The quality assurance matrix among the NCC procedures allows to freely defining these quality control measures at each site, but it also means that the site management is responsible for the adequacy of the quality assurance measures. (http://projectia2.ncc.fi).

The quality assurance matrix must state the most critical work entities / subcontracts in terms of the site's technical quality, time schedule and finances. The quality control related to these work entities is carried out by the following procedures:

- Task plan (work phase plan)
- Site kick-off meeting
- Receipt of worksite
- Mock-up installation and review
- As-built measurements, inspections and testing
- Reception of parts and sections (inspections of contract performance) and acceptance inspection

Any matters agreed at the site kick-off meeting, requirements for site inspection documents, client requirements for quality control, and quality control carried out by client must be considered in connection with the preparation of the quality assurance matrix.

When planning the quality assurance matrix, any information about defects liability and 5 years' liability repairs and results of site risk analysis are considered.

The implementation of the procedures according to the matrix is documented in Minutes of Meeting, memoranda, forms, drawings and an inspection document, or at least as a remark made in the builder's diary.

5.6.7 Health and safety

The site health and safety planning starts from charting of safety risks, in which case the risks involved in the project implementation are identified and the necessary measures are planned in order to prevent them. In support of site health and safety planning the employer-furnished safety document is used.

Every site is assigned a health and safety officer to carry out the agreed inspections under the site manager's supervision.

Site health and safety inspections

In order to ensure general site safety and remove risks, site health and safety inspections are held throughout the construction phase.

- Acceptance inspections (scaffolding, lifting equipment, machinery)
- Maintenance inspections (regular measurements)

The requirements and implementation of the inspections are in more detail described in NCC site health and safety folder.

Most of the site safety factors are related to work phases to be performed. Therefore, the site safety matters must be ensured at the work planning of each work phase. The identified safety requirements are considered at the work phase kick-off meeting and their fulfillment is monitored at site health and safety inspections as well as in quality control and monitoring procedures directed at the work phase. (http://projectia2.ncc.fi).

5.6.8 Customer site visits

During the construction customers can visit the construction site. They are to be accompanied by the representative of the sales department. The schedule of visits is to be approved by the construction site manager. All necessary safety equipment is to be given beforehand. Visitors are to be instructed on safety rules and precautions and have to put signatures to the journal of site visits. Children younger than 10 years are not allowed to visit the site.

5.7 Completion and Commissioning

The most important stage of any project is completion, creation of documentation, delivery of the object of the state commission and turns it into a permanent operation. Completion and Commissioning is divided into five units: Finishing of Site, Commissioning and Hand Over, Finance, Post Analysis and Customer divisions.

5.7.1 Finishing of site

Site finishing is ensured by planning and implementing a finishing programme. A finishing program is a procedure based on the quality principles of construction in which the site itself guarantees the contractual quality at the point of handing over.

In order to efficiently realize the finishing program the adequately authorized client's representatives must participate in it to define the correct finishing level. The essential subcontractors involved in the finishing works must be instructed and committed to the realization of the finishing program. (http://projectia2.ncc.fi).

The finishing program includes the following phases:

- The project is divided into purposeful sections and inspection areas.
- A finishing schedule is prepared which defines the finishing order, preliminary inspection dates and timing of post-completion inspection. The initial data for the finishing schedule are retrieved from the interior finishing schedule. A good interior finishing schedule creates the preconditions for a successful finishing program.
- Inspection walks are directed, at which any defects and shortcomings discovered are recorded and submitted to all participants of the finishing works. Inspections are held by the site manager or the construction / project manager. Should any works be found not having been executed at all during the inspection walk, this means a time schedule problem. A time schedule problem must be eliminated by means of site production control.
- Corrective action is organized and realized so that the agreed remedies can be made by the agreed date before the post-completion inspection.

- A post-completion inspection is held at which the appropriate elimination of defects and shortcomings is established. Documentation of post-completion inspections also serves as acceptance inspection material by which the construction company proves that the project has been finished and that it is flawless.

5.7.2 Commissioning of construction works

State Architecture and Construction Inspectorate (GASN) makes a final inspection on invitation of the developer: checks the conformity of works performed with design documentation, requirements of the technical regulations, engineering surveys results, requirements of land plot development plan; inspects the construction site, structures and also checks the as-built documentation. (http://projectia2.ncc.fi).

By results of the inspection and elimination of remarks GASN prepares a decision of project conformity with the technical regulations and design documentation requirements.

After that the Developer sends to the city administration an application for commissioning certificate, having necessary documents attached (the list is below).

The following documents are to be attached to application for commissioning certificate:

1) Land plot title documents;
2) Land plot development plan;
3) Building permit;
4) Certificate of capital construction project acceptance
5) Document approving the conformity of project built with the technical regulations and signed by a person, implementing construction;
6) Document approving the conformity of parameters of capital construction project built with design documentation and signed by a person, implementing construction;
7) Documents approving the conformity of project built with specifications and signed by representatives of companies, operating the engineering utilities.

8) Schematic displaying location of capital construction project built, location of engineering utilities within land plot and plot layout, and signed by a person, implementing construction

9) Decision of state construction supervision agency (if state construction supervision is provided) concerning the conformity of project built with the technical regulations and design documentation.

The commissioning certificate authorizes to state register the capital construction project built.

5.7.3 Final settlement for project

A final settlement for a project is the most important part for the settlement work with a Client.

To make a final settlement of a project the following steps should be taken:

1. All acts for all works on the project should be collected from subcontractors and handed over to the Finance department
2. The Finance department checks that no acts are missing (no open advance are on the ledger)
3. The Finance department and the Cost Controller check that all costs booked to the general ledger are equal to the costs booked to the Cost ledger to insure that no costs are missing
4. The Chief Accountant and the Project manager check what is the final fee to be accrued for the project according to the contract (often the target price should be compared to the actual price and based on that the fee may be calculated with the different percentage)
5. On estimation of final fee to be received from the Client the Finance department issues the final invoice
6. The Finance department checks that there are no receivables left with the Client. The final Act of cross-checking is signed up with the Client
7. The Finance department checks that there are no payables left with subcontractors. Final Acts of cross-checking are signed up with subcontractors. (http://projectia2.ncc.fi).

5.7.4 Post-completion analysis of site

A post-completion analysis of a site is made to give an appraisal on the successes and failures of a newly-completed project. The making of a post-completion analysis is the responsibility of the site management. The purpose of the analysis is to form a common notion for the participants on the reasons that resulted in a success or a failure. The post-completion analyses are participated by the site management, project purchasing and cost control.

The secondary purpose of a post-completion analysis is to acquire information to the unit's common use. The summaries of site post-completion analyses are considered at unit meetings / inspections by management.

The following matters are assessed at the post-completion analysis:

- Commencement of the project, organization and management
- Cost estimation and contract
- Project's financial result
- Site time schedule, planning, supervision
- Planning and control of project quality
- Site purchases and subcontracts
- Site tidiness, health and safety
- Environmental aspects
- Customer satisfaction and feedback

The post-completion analyses are recorded by preparing Minutes in which the essential results, conclusions and possible further action are written down. At the conclusion of a post-completion analysis three best things about the site and three considerable development areas are also marked. (http://projectia2.ncc.fi).

5.7.5 Project handing over to Customer

The aim is to hand over to the customer a product at the agreed time and in the agreed way. The project handing over is based on the agreement and other negotiations held with the customer concerning the handing over process. The precondition for successful handing over is a properly done finishing program.

The project is handed over at an acceptance inspection. In the absence of any considerable defects related to the acceptance the client accepts the product in their own use. After a project has been handed over, responsibility is transferred to the client. At the handing over the client is given up-to-date production drawings, as-built drawings of the mechanical and electrical works, insurance documents, and instructions for use and maintenance of basic equipment, maintenance log (home binder). A list of the documents provided to the customer is to be fixed at the kick off commissioning meeting.

The developer has to provide the client set of documents needed for ownership registration.

Attachments are regulation for the document preparation and acceptance-transfer of the apartments and nonresidential premises by the investment construction projects.

A list of documents is given to the customer for the ownership registration.

5.8 Maintenance

The last stage Maintenance contains Guaranteed and Liabilities, and Customer steps.

5.8.1 Closing of Investment

Investment can be closed when:

- All obligations are moved to clients.
- All guarantee period claims are handled.

5.8.2 One-year inspections

One-year inspections are arranged for the housing association and for the occupants. At the inspection any defects that have been reported by the customers and discovered in the apartments and common premises are verified.

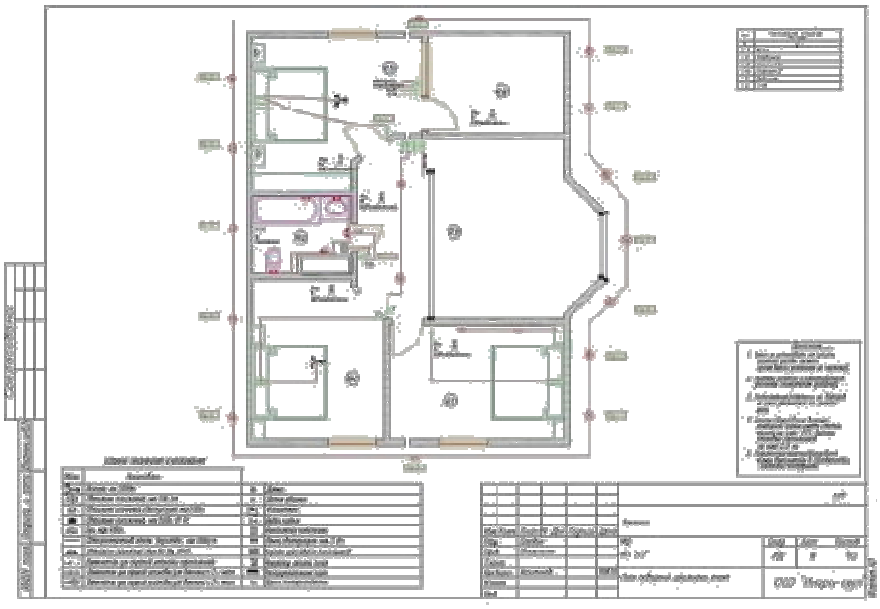
After the one-year inspection the developer may incur liability only for hidden defects basically excluding gross neglicence and exceptions causing health hazards. (http://projectia2.ncc.fi).

1. NCC sales department sends the questionnaire to the customers. If they have any defects they would like to be fixed by NCC (list of the works which are included into the guarantee is enclosed)
2. NCC Sales department makes a list of works by apartments
3. List of works is approved by the construction department
4. Repair works are done.
5. Feedback -after one year- is collected.

6 VIRTUAL AND DESIGN CONSTRUCTION (VDC)

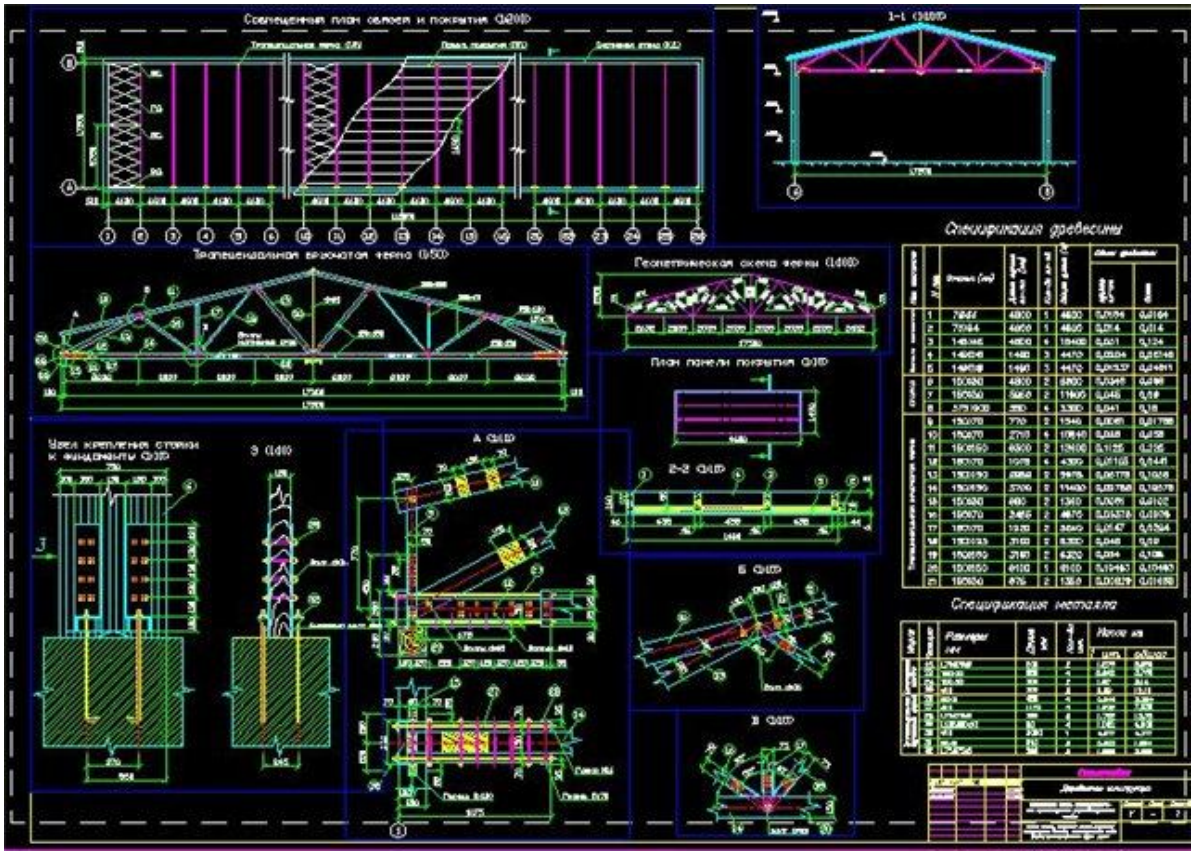
The design process in our days is faster, more handy and convenient than 10-20 years ago, when each project had to be drafted on the paper by hand. You can see hand-drawing in figure 6.1. It needs a lot of time and good health because it is hard work.

Figure 6.1 The plan drawing made by hand.



Once AutoCAD has been actively used by engineers the task became easier, because AutoCAD facilitates design of buildings. AutoCAD is the most widely used design software. Figure 6.2 shows the AutoCAD building drawing.

Figure 6.2 The example of AutoCAD drawing.

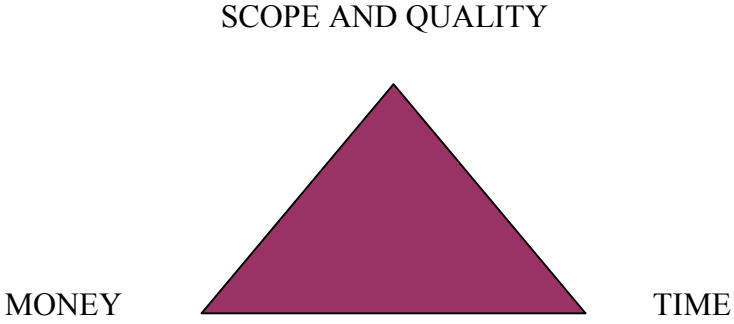


But the software has gone further and allowed to create a 3D model, which is much more convenient for both the designer and the customer, who until this time had to understand the two-dimensional drawings. This model could help to create by different software such as Autodesk ArchiCAD, Autodesk Revit and КОМПАС (Russian software) and others. These programs allow drawing a parametric model of a building which incorporates a 3D model and external data. The model is correctly updated when some changes are needed for its elements. All model elements are related dependencies. If you change the model, documentation is updated automatically. This system is called Building information modeling (BIM). Figure 6.3 shows the 3D model of a building.

Figure 6.3 The example of 3D model of a building.

But it was not enough, at that stage it seemed that it is possible to facilitate the construction design, including project managers. The Construction prototype is shown in figure 6.4.

Figure 6.4 The triangle of project management describes the balance between the content of the project cost, time and quality. Quality was added later, so the triangle was originally named by a threefold limitation.



Building Information Modeling could help with scope and quality in design stage. But money and time is needed to calculate in other programs. To reduce these problems to zero Virtual Design Construction was developed.

6.1 The term VDC

Virtual Design and Construction (VDC) is management of multi-disciplinary performance models of design-construction projects, including the product (i.e. facilities), work processes and organization of the design - construction – operation that are used to visualize, analyze and evaluate the performance of these projects.

The use of VDC technologies has been proven to significantly reduce project time and cost by decreasing errors and omissions, increasing site safety, enabling more effective communication of the project scope, improving project coordination, and minimizing changes.

VDC is a 5D technology. It consists of

Product modeling - Building Information Modeling (BIM)
Organization modeling
Process modeling

As usual Virtual Design and Construction technology is done in three distinct phases, each of which has its own strategy.

In the first phase models of the Product in 3D, the Organization that performs design, construction and operations and the Process are created and followed by organizational participants to do design, construction and operations and management, based on performance metrics. Clear project objectives, values, responsibilities, designs and expectations due to good visualization enables many more stakeholders to participate in project review far more meaningfully than in routine practice.

In the second phase, the data is exchanged among disparate modeling and analysis applications by computer-based automated methods [Kunz and

Gilligan 07]. For Integration to work well, vendors need to agree on exchange standards, which may require a strategic commitment to support cross-vendor data exchange.

Reliable computer-based data exchange is required here to share data among Product, Organization & Process models and analysis programs.

The investment in VDC tools, methods and human resources need to based on their project value proposition. (J.Bedrick, AECbytes)

In the last third phase, projects use automated methods to perform routine design tasks, to improve design, project organizations and perform more high-value design and analysis and spend much less time for routine design. It enables dramatic increase in design efficiency and effectiveness, enables dramatic decrease in construction duration, which in turn leads to breakthrough project performance in construction duration.

Paper documents today provide high-resolution descriptions of project elements including architectural designs and plans. However, the discrete paper based documents do not help integration of different disciplines and making even simple changes requires hours to days to make the initial change, print and review the updated documents and do even simple updates to related documents of functionally related disciplines. In addition, the format of today's paper documents is often difficult for diverse stakeholders to understand: for example, users can rarely make meaningful comments about 2D architectural drawings or Gantt charts. The VDC project models is flexible, visual and interactive, not document or paper-based. The engineer who generates the VDC schedule can project it and show it to other stakeholders who have responsibility for the CAD model or some area of the design or construction.

Inexpensive computers and large, high definition and inexpensive projection devices enable social sharing of VDC computer models, and the modeling and simulation applications are now powerful and affordable. (Kunz & Gilligan, 2007)

VDC creates an integrated framework and set of methods to manage the project, including those aspects of the project that must and can be designed

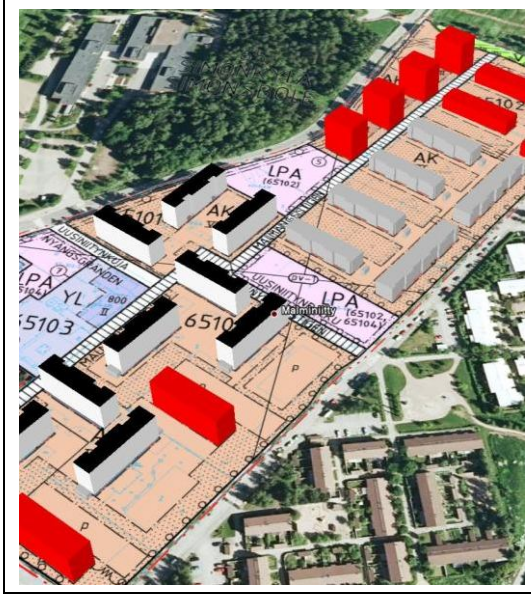
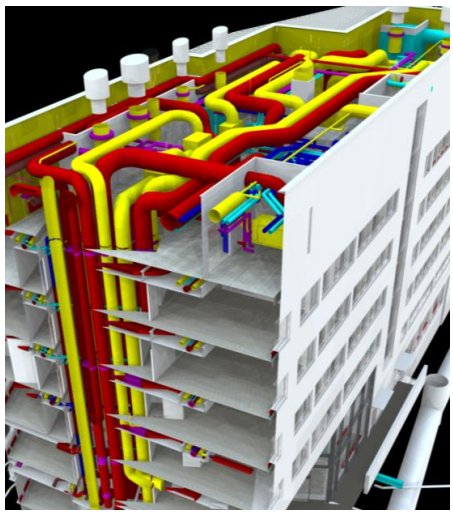
and managed, i.e., the building, the design-construction process and the organizations that follow the processes to design, build and use the building. Building Information Modeling (BIM) focuses on the building elements of the VDC model, which is found useful but limiting because management issues usually involve building – organization – process interactions.

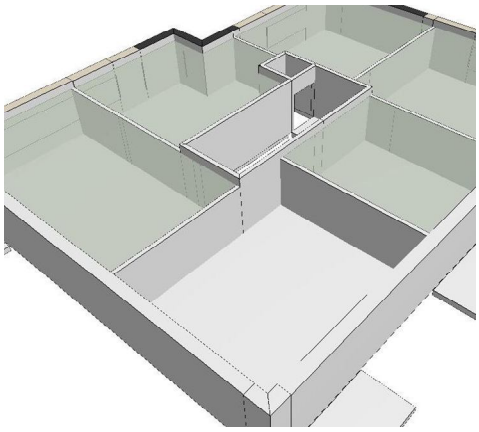
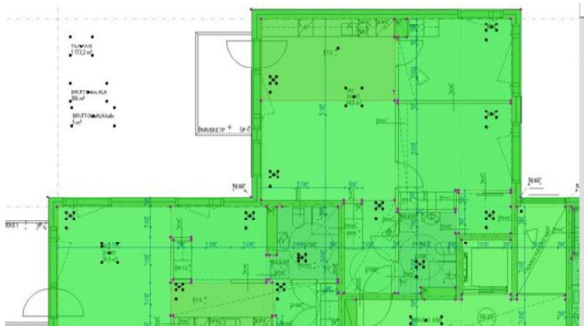
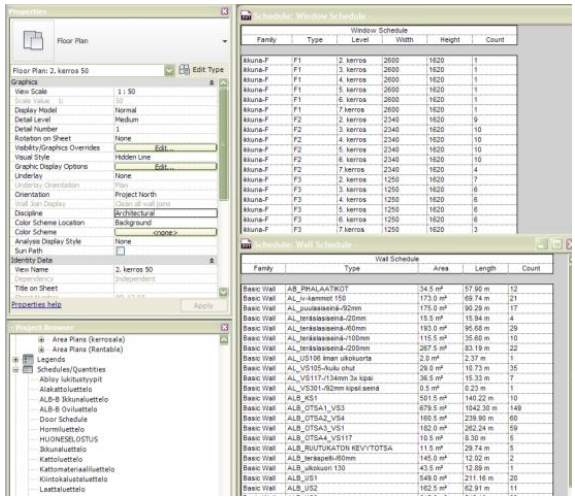
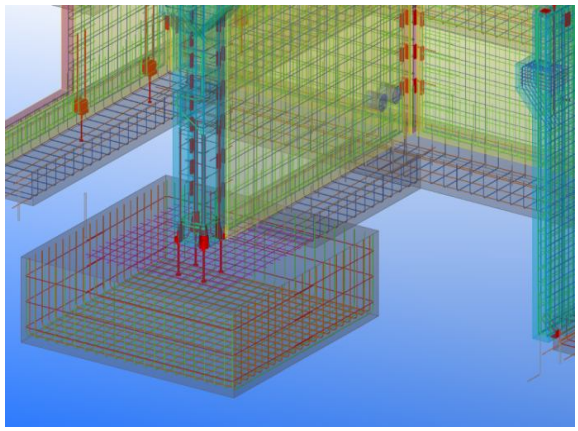
6.1.1 Development plan for the VDC in NCC

NCC Company is an up-to-date company. It needs to develop new technology and use it in practice. The Development department has its own plan to adopt novelty in the projecting process. The following is a brief development plan of VDC for NCC Company. Table 6.1 shows the options of the first stage of the introduction of the Virtual Design and Construction technology. Table 6.2 shows the further development and implementation of technology for cost estimation, procurement and maintenance. Table 6.3 shows the desirable deployment of VDC to the construction site.

The 1st stage: 3D Model

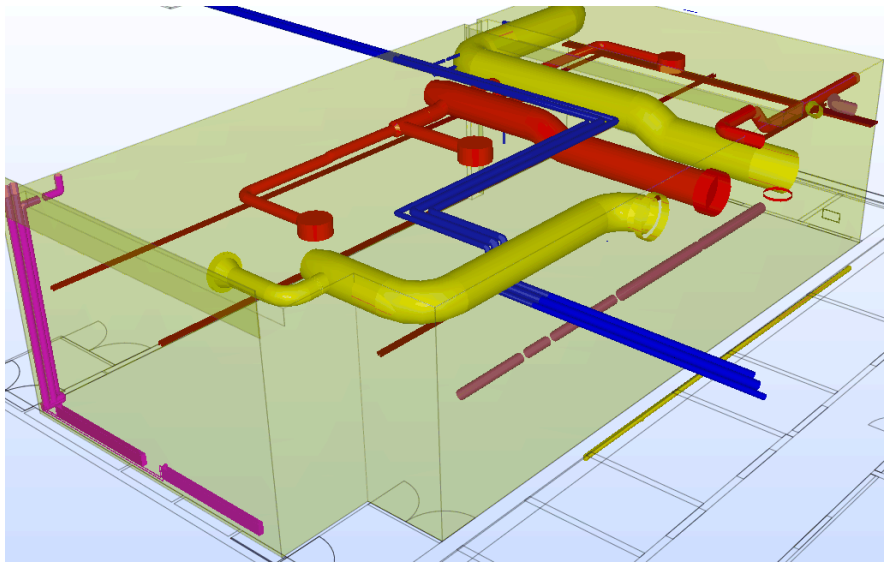
Table 6.1 Possibilities of Revit program.

3D Architectural Model	3D Structural Model
Area plans 	Engineering system: Mechanical, electrical, and plumbing (MEP) 

Sketching 	Dividing zones 
Early designing 	Quantities 
Final designing 	Reinforcement 

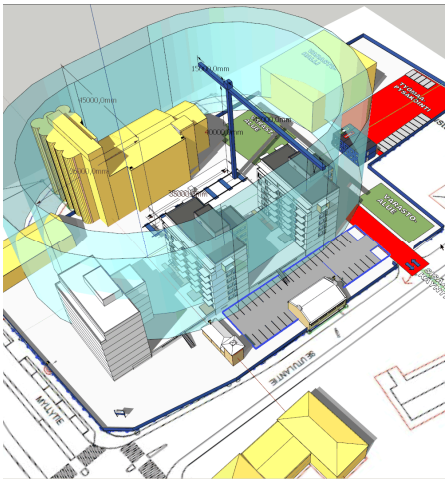
The 2nd stage:

Table 6.2 Positive additions of MEP (mechanical, electrical and plumbing) part of Revit

Cost estimating Procurement Maintenance	

The 3rd stage

Table 6.3 Desirable development of VDC system

Introduction to the construction site	
3D site-plans	

Prints on the site	
Surveyor and coordinates from 3d-model	

6.1.2 Autodesk Revit program

VDC introduction should start with 3D model. One of the programs that can do it is Autodesk Revit.

Autodesk Revit is 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. Document designs more accurately using coordinated and consistent information inherent in the intelligent models. (http://usa.autodesk.com).

6.1.3 Autodesk Revit program for NCC Company

The work began with creating the model of building. The object is located at the address Leningradskaya oblast', Vsevolozhsk area, lands of ZAO "Scheglovo". The total area of the apartments is approximately 200,000 m². The total number of apartments is approximately 1496 pieces. The land plot has been divided by 5 residential groups. The 1st group includes:

- 9 buildings, 6 floors
- 384 flats, total selling area is 23 000 m².
- 4 construction stages (2, 2, 3, 2 buildings in each stage)

For the 1st one only 2 different types of blocks will be used. The type B has rectangular of with dimension 37,8x16,2. The building height is 18 meters and the floor height is 3.15 meters.

The buildings are going to be constructed from prefabricated elements. Self-supporting external walls and load-bearing external walls below zero are prefabricated sandwich panels. Internal walls are prefabricated single-ply panels. External walls on the butt end are load-bearing single-ply panels with subsequent insulation and cladding. External walls along the longitudinal axes

are self-supporting single-ply panels with subsequent insulation and cladding. Internal walls are precast reinforced concrete single-ply panels. Balcony slabs are precast reinforced concrete panels. Columns are made of precast reinforced concrete with a rectangular cross-section. Elevator shafts are made of precast ferroconcrete.

Windows and balcony doors are made with energy efficient double layer system. Entrance garage gate is automatic, overhead, in fire walls – sliding of the required fire-resistance.

Joints and parts are developed by the company fulfilling works under the task of the design company.

Roof on the buildings is flat, rolled-up, guided with a protective layer, ventilated. Multipurpose flat roof, inversion roof is used at the parking place. To establish outer fire escape the metal stairs in the places are located of the height difference of more than 1 meter.

In the outer wall of a building over openings zinc coated angle (brick layering) + reinforcement cross-piece (gas concrete) is used. Inner walls are made of brick. The rest is prefabricated reinforced concrete.

Ceiling slabs are flat prefabricated reinforced concrete. Flooring panels are flat prefabricated ferroconcrete. Flooring beams are prefabricated reinforced concrete.

At first the model of type B was built in Autodesk Revit Structure. Plans for the first and the type of floors, roofs, basement floors, facades and construction schemes have been developed by designers in AutoCAD. Revit software allows to load AutoCAD designs and to draw the walls and other details on the existing structure. Figures 6.1and 6.2 shows the load AutoCAD drawings and the newly created walls in the Autodesk Revit.

Figure 6.1 The created first floor in Autodesk Revit with AutoCAD drawing

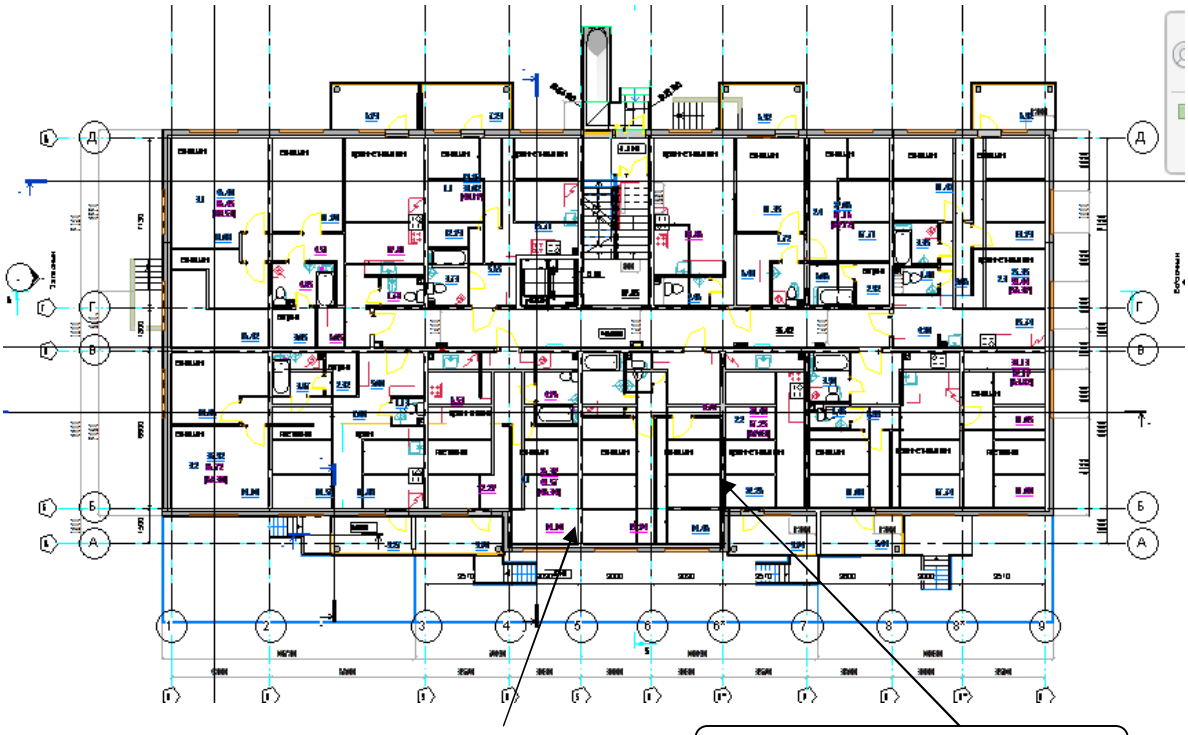


Figure 6.2 The plan of roofs from AutoCAD and Revit structure

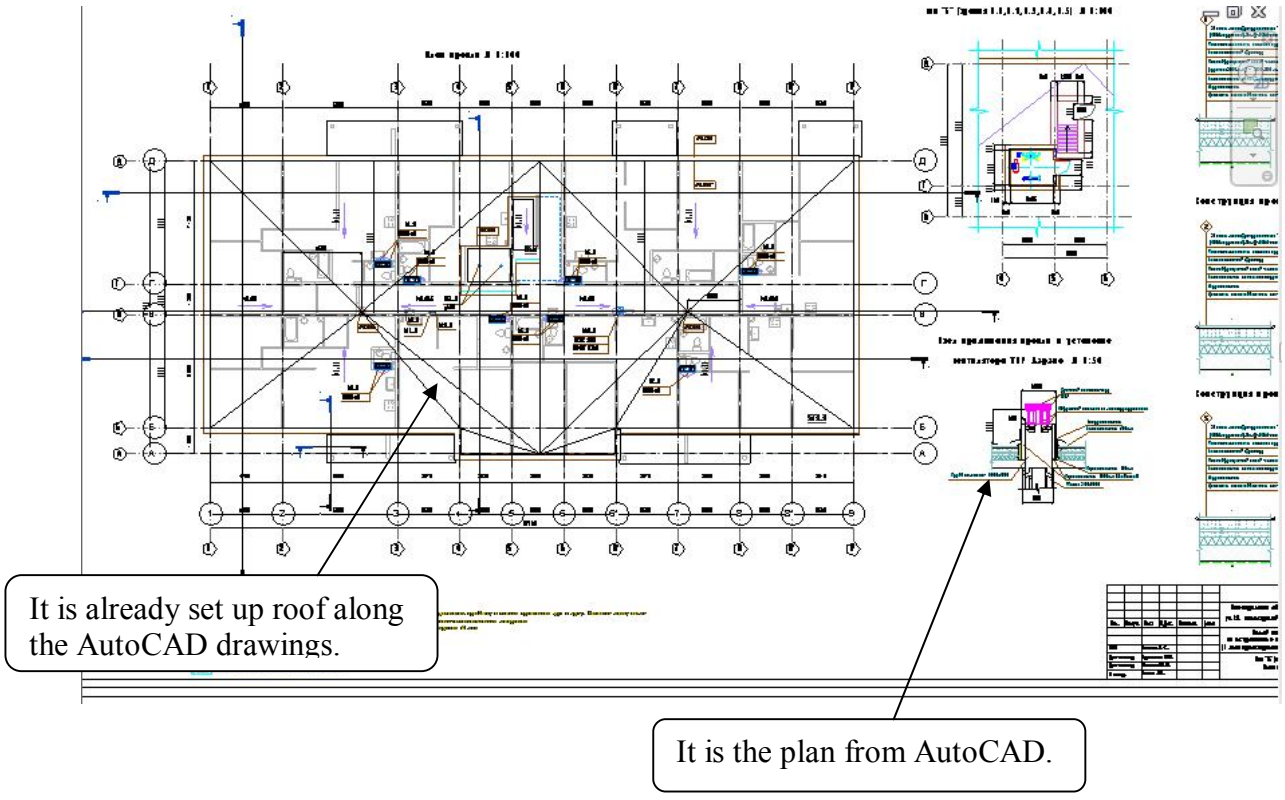


Figure 6.3 The 3D model of type B. It is created by Autodesk Revit itself simultaneously with the construction of plans.

Figure 6.3 3D model

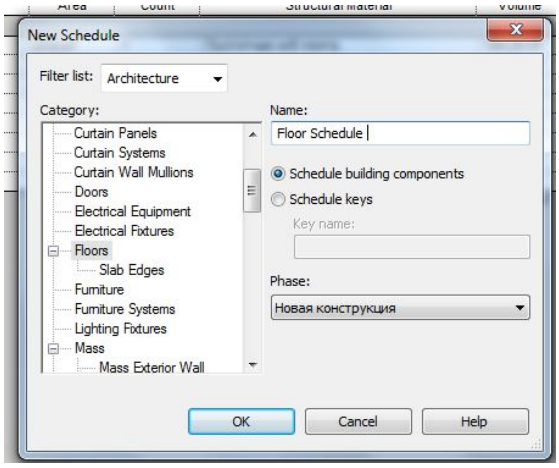
In the Autodesk Revit program you can move and rotate the model, also you can hide some of the elements that is very convenient for viewing internal components. The wall structure varies depending on its functions. The standard size of doors and windows can be created in accordance with the project. As the roof has a slight slope to the water drainage funnel and has irregular shape it was created with the help of formative elements which have roof structure.

6.2 Creation of the schedule

The schedule or specification for Autodesk Revit is called a view in the form of a table, which contains data extracted from the project; these data are automatically selected from the properties of certain components and are substituted in the field of specification. (Ланцов А. Л., 2009)

Specification is just a view of the project and if the project will be changed, the specification is changing too. Figure 6.4 shows the table on which the category is selected.

Figure 6.4 Panel to select the category



In this table you can select any category you need, for example, ceilings, or walls, or doors etc.

Figure 6.5 shows the final form of specification

Figure 6.5 Floor schedule

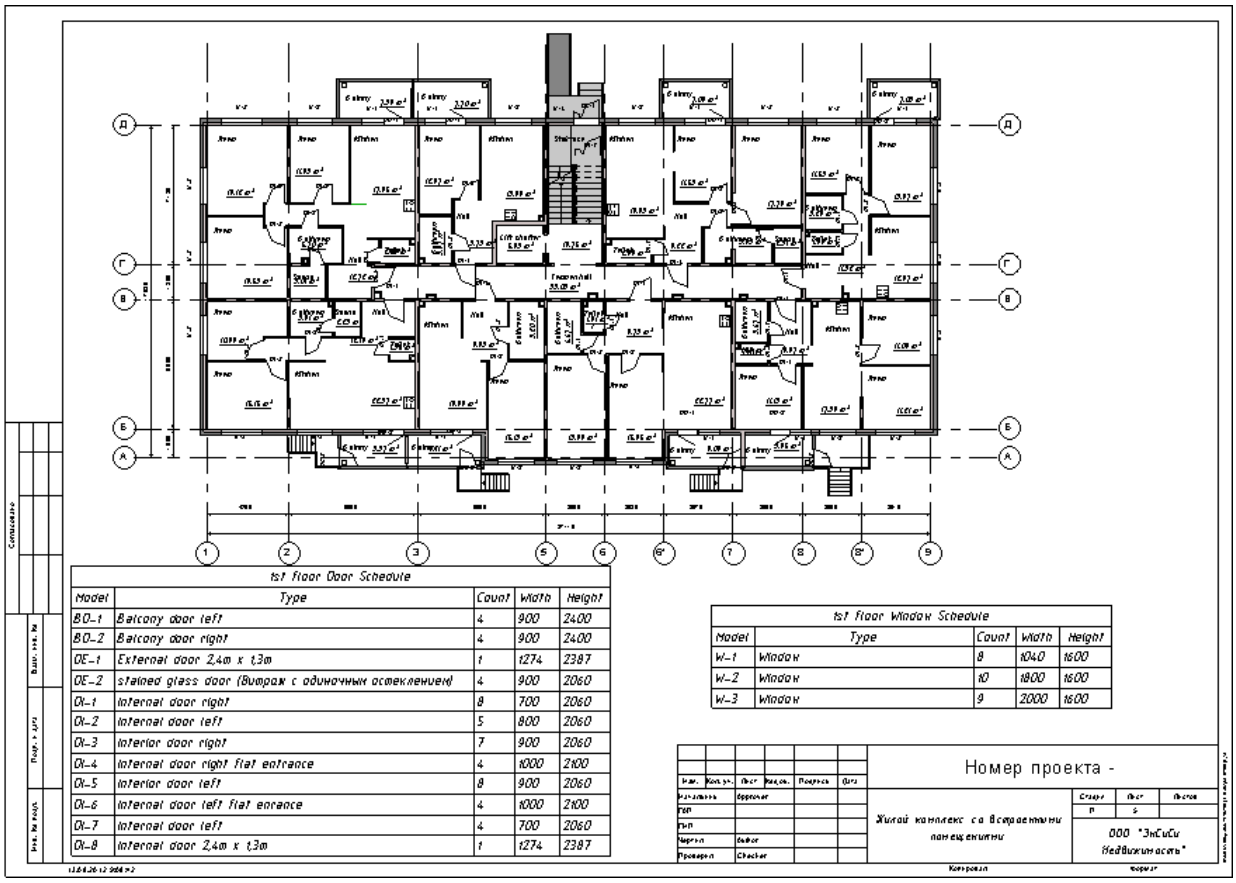
Floor Schedule

Type	Area	Count	Structural Material	Volume	Cost
Ceiling (Потолок)	3523 m²	6	Toning - whate - Тонирование - Белый	35.23 m³	0.00
Floor 1st floor-basement (Пер	614 m²	1	Hollow concrete slab - Пустотная ж/б плита	184.13 m³	0.00
Floor (Полы квартир перекры	3687 m²	6	Hollow concrete slab - Пустотная ж/б плита	995.45 m³	0.00
Hall's floor (пол для коридора	366 m²	5	Hall tile - Плитка коридор	3.66 m³	0.00
Kitchen's floor (пол для кухни	895 m²	6	Wood-Cherry - Древесина - Вишня	8.95 m³	0.00
Room's floor (Полы комнат)	1475 m²	6	Surface (laminate or parquet) - Покрытие по	14.75 m³	0.00
Staircase&common hall floor(п	338 m²	13	Common hall tile - Плитка общий коридор	3.38 m³	0.00
Toilet's&Bathroom's floor (пол	388 m²	7	Tile 2 - Плитка 2	3.88 m³	0.00

7 THE FINAL MODEL

A model usually has many lists of drawings with architecture, structure and utilities design. To get right results it approximately the same list of drawings was created. These typical sheets have drafting frame, title and specification besides drawing. Figure 7.1 shows the example of one sheet.

Figure 7.1 The first architectural sheet with areas of rooms, door and window specification.



1st floor Door Schedule

Model	Type	Count	Width	Height
BD-1	Balcony door left	4	900	2400
BD-2	Balcony door right	4	900	2400
DE-1	External door 2,4m x 1,3m	1	1274	2387
DE-2	stained glass door (Витраж с одиночным остеклением)	4	900	2060
DI-1	Internal door right	8	700	2060
DI-2	Internal door left	5	800	2060
DI-3	Interior door right	7	900	2060
DI-4	Internal door right flat entrance	4	1000	2100
DI-5	Interior door left	8	900	2060
DI-6	Internal door left flat entrance	4	1000	2100
DI-7	Internal door left	4	700	2060
DI-8	Internal door 2,4m x 1,3m	1	1274	2387

1st floor Window Schedule

Model	Type	Count	Width	Height
W-1	Window	8	1040	1600
W-2	Window	10	1800	1600
W-3	Window	9	2000	1600

Номер проекта -

Жилой комплекс со встроенными помещениями

ООО "ЭнСиСи Недвижимость"

Figure 7.2 shows the southern elevation with finish on the preliminary project. Level head satisfactory standards.

Figure 7.2 The southern elevation

Figure 7.3 List of flats with areas and names

Figure 7.4 shows the HVAC system. Heating, hot and cold water supply, sewarage and ventilation are shown. There is a set of explanatory signs below the drawing.

Figure 7.4 Heating, water supply, sewage and ventilation for the typical floor.

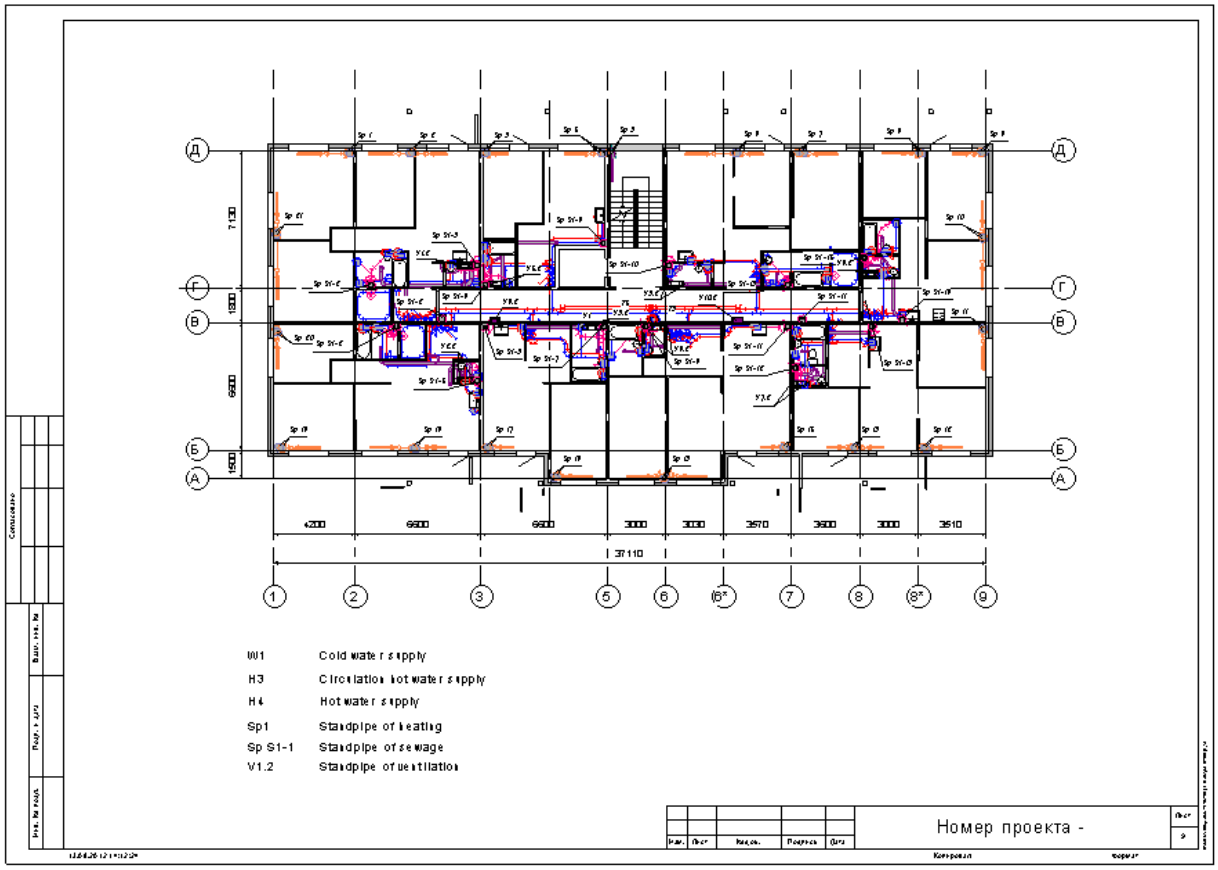


Figure 7.5 Example of specification for HVAC system.

Pipe Schedule Спецификация труб

System Type	System Name	Type	Size	Count	Material	Length
Domestic Cold Water Холодная вода	B1	Metal-plastic pipe for circulation	13ø	40	Polyvinyl Chloride - Rigid	31530
Domestic Cold Water Холодная вода	B1	Metal-plastic pipe for circulation	25ø	6	Polyvinyl Chloride - Rigid	2980
Domestic Cold Water Холодная вода	B1	Sauna Сухотруб	25ø	4	Steel, Carbon	5940
Domestic Cold Water Холодная вода: 50				50		40450
Domestic Hot Water Горячая вода	T3	Metal-plastic pipe for circulation	13ø	23	Polyvinyl Chloride - Rigid	19260
Domestic Hot Water Горячая вода	T3	Metal-plastic pipe for circulation	25ø	4	Polyvinyl Chloride - Rigid	960
Domestic Hot Water Горячая вода: 27				27		20220
Heating Отопление	T1	Heating	13ø	5	Stainless Steel	5020
Heating Отопление	T1 room 1	Heating	13ø	5	Stainless Steel	6200
Heating Отопление	T1	Heating	13ø	3	Stainless Steel	4530
Heating Отопление: 13				13		15740
Heating Отопление 2	T2	Heating	13ø	5	Stainless Steel	5000
Heating Отопление 2	T2 room 1	Heating	13ø	5	Stainless Steel	6220
Heating Отопление 2	T2	Heating	13ø	3	Stainless Steel	4640
Heating Отопление 2: 13				13		15850
Sewarage Канализация	K 1	PVH (стояки канализации+разводка)	51ø	9	Polyvinyl Chloride - Rigid	3350
Sewarage Канализация	K 1	PVH (стояки канализации+разводка)	102ø	2	Polyvinyl Chloride - Rigid	2890
Sewarage Канализация	K1	PVH (стояки канализации+разводка)	51ø	11	Polyvinyl Chloride - Rigid	3530
Sewarage Канализация	K1	PVH (стояки канализации+разводка)	102ø	3	Polyvinyl Chloride - Rigid	2940
Sewarage Канализация: 25				25		12720
Grand total: 128				128		104990

In this figure 7.5 you can see a specification with pipe length for all systems of building. Revit automatically calculates what is comfortable and convinient and eliminates possible errors.

SUMMARY

To have easy understandable construction drawings for a production process is very important. In short manner the drawings are able to describe sizes, shape, position of structures, as well as specification of materials and even technology. Improvement of the quality of the construction drawing could lead to better project management. VDC system helps to create, to assume and to control all phases of construction.

Computer software has improved a lot and new methods for creating projects have appeared. At the beginning implementation of new systems need a lot of effort, time and money. If the company can allow itself to spend those means the revenue will come quickly enough, and company efficiency will be improved

For summarizing the main conclusion of the thesis it is possible to insist on usefulness of the Revit program. The possibilities are great, for example:

1. 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.

2. 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.

3. 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.

4. 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.

5. During the process of 3D modeling on the basis of 2D drawing plenty of errors can appears. 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.

6. 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.

7. 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.

8. 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.

This thesis can be used by NCC as research on the benefits of improved computer software and changing requirements for designers. But the program has also disadvantages. For an accurate work of the Revit program it is necessary to have powerful computer hardware and designers need to have knowledge of working in the program which leads to extra costs. But even that should not scare the company from using: prevention of some cruel design mistakes can easily cover those spending as well as money for possible design changes.

FIGURES

TABLES

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