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

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Implementation of BIM in construction project

Bachelor's Thesis 2016

ABSTRACT
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Saimaa University of Applied Sciences, Lappeenranta
Degree Programme in Civil and Construction Engineering
Bachelor's Thesis 2016
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The aim of the thesis was to analyse the actual technology in BIM-design of modern construction in Russia and to create a technical task for the designing of BIM model.

The first part of the thesis consists of general information about BIM, the actual situation in Russia, national standards for BIM in Russia, some words about OpenBIM and situation with BIM in YIT Saint-Petersburg.

The general part of the thesis contains a technical task for the designer which was made for the YIT Saint-Petersburg according to engineer's and project manager's requirements, and the plan for future: How to improve the quality of a construction project with the help of BIM technologies.

The technical task was developed for the designing of BIM model for all project stages and parts and contains requirements to levels of development for each stage of a construction project.

A lot of information was analysed from conferences, titles and national standards.

In the process of writing the thesis a conclusion was made how to use BIM more effectively in the future projects. In the future this survey can be applied by the company as a guideline.

For using Building Information Model more effectively the company should start to implement that technology in all building processes and all departments which are taking part in the construction process should be educated to use BIM software and to understand the whole system of BIM. Those steps will help to use all advantages of Building Information Modelling on all stages during the life-cycle of the object.

Keywords: BIM, implementation, construction

CONTENT

1 Introduction

BIM (Building Information Modelling) is the creation and use of information about the construction, which forms a solid basis for all decisions over the lifetime of the object – from concept to constructed object. (According to Autodesk “What is BIM?”)

The problem of effective designing and construction without mistakes is very actual at the present time. There are a lot of examples when the final cost is higher and the schedule of the construction is longer. BIM technologies can help to avoid these mistakes and to make the construction project more effective.

The implementation of BIM is not a transition to a new program, this is the implementation of the new technologies to work with objects, including a new approach to design, a new level of organization of construction, completely different ways to manage the exploitation.

The aim of the thesis is to analyze the actual situation in Russia in BIM-modeling to create a technical task for the company and to make conclusions how to improve the quality of the future construction projects with the help of BIM.

The work contains the following themes:

- General information about BIM
- National standards for BIM in Russia
- Actual situation with BIM in Russia
- Situation with BIM in company YIT Saint-Petersburg
- Technical task for the designer of BIM model, according YIT requirements
- How to make BIM more effective in the future projects

The technical task contains requirements of the engineers and project managers from YIT Saint-Petersburg to BIM model. Those requirements will be used by the company in the future contracts with the designers and will help to avoid mistakes and to make cost estimation more precisely.

This topic is actual, because a lot of construction companies start to think about implementation of BIM technologies and Russian Ministry of construction started realizing the plan for phased implementation of BIM technologies in the civil and industrial constructions.

2 BIM

2.1 Definition of Building Information Modeling (BIM)

Building Information Modeling (BIM) is the process of collective creation and use of information about the construction, forming a reliable basis for all decisions over the lifetime of the object (from the early concepts to detailed engineering, construction, operation, modernization and demolition) (http://www.autodesk.ru/campaigns/aec-building-design-bds-new-seats/landing-page).

The use of BIM does not stop after the building is designed and built, after that begins the phase of operation and maintenance. In future life of the building BIM can be used for renovation and demolition

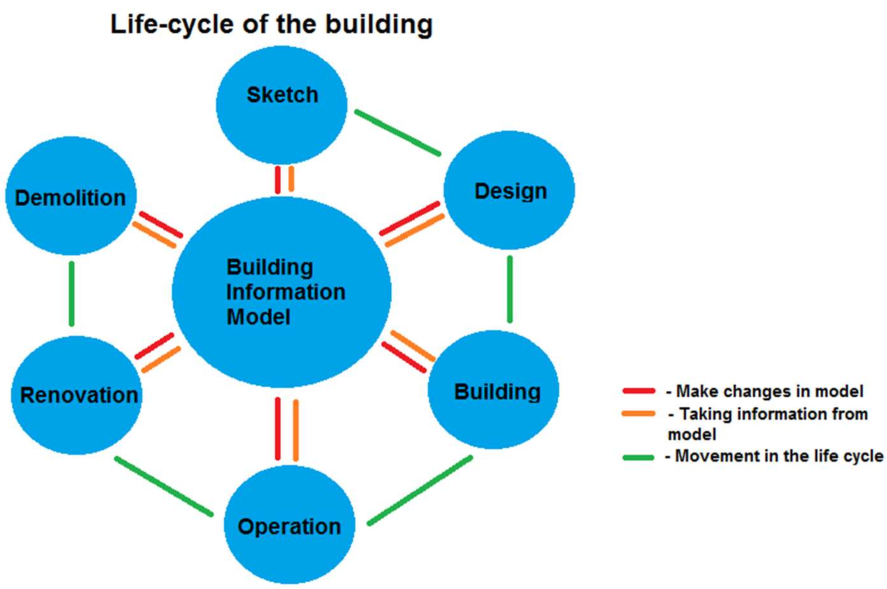

Figure 1. Life-cycle of the building information model

The three-dimensional model of a building or other construction project is related to the information database, in which each element of the model can consist of additional attributes.

The main idea is that a building project is designed as a single unit, and a change in one of its parameters entails automatically a change in the other related parameters and objects, also the drawings, renderings, specifications and timetable.
Consulting company McGraw Hill Construction make a survey
among companies in the construction industry and find out what advantages
they got from implementation of BIM. According to The Business Value of BIM in North America 2012, 41% of the surveyed companies noted a reduction of number of errors after the introduction of technology and 35% and 32% paid attention to the improvement of communication between managers and designers and improvement of the company image.
(The Business Value of BIM in North America, 2012)

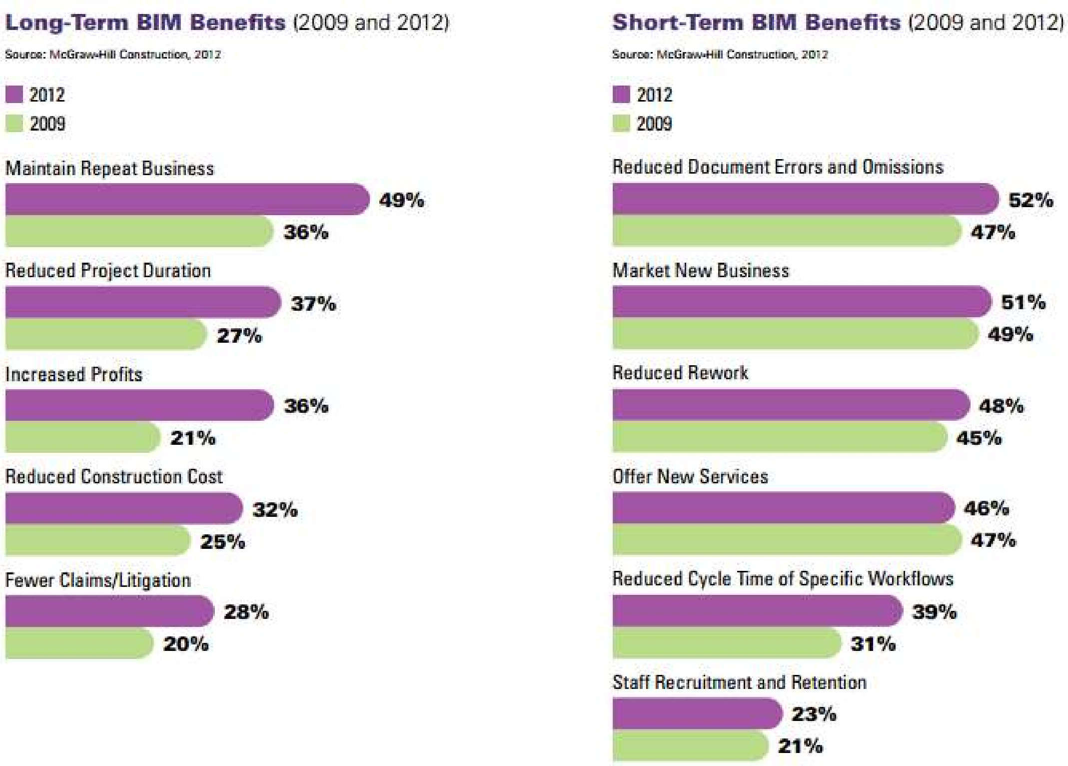

Figure 2. Long-term and short-term BIM benefits. (The Business Value of BIM in North America, 2012)

2.2 History of the term BIM

The term appeared in the lexicon of BIM experts recently, even the concept of computer modeling with maximum information about the object began to emerge much earlier. Since the end of the twentieth century, such an approach in the design was born with the rapid developing of CAD-technology.

The term of building information model was first proposed by Chuck Eastman professor of the Georgia Institute of Technology in 1975 in the Journal of the American Institute of Architects (AIA) Building Description System

In the end of the 1970s – beginning of the 1980s, the concept was developed parallel to the Old and New World, and in the United States often was used the term Building Product Model, and in Europe (especially in Finland) - Product Information Model. And both times the word Product emphasized the primary orientation of the attention to the design of the object, rather than the process. It can be assumed that the simple linguistic unification of these two titles create the term Building Information Model. These linguistic connections of two words led to the first appearance of the term Building Information Model in the scientific literature in 1992.
Earlier, in 1986, Englishman Robert Ashe (Robert Aish), creator of the program RUCAPS, and then for a long period worker of Bentley Systems, recently converted to the Autodesk, he used the term Building Modeling in his article firstly. He formulated the basic principles of this approach in the design of information: the three-dimensional modeling; automatic acquisition of drawings; intelligent parameterization facilities; the corresponding objects in the database; distribution of the construction process on temporary stages, etc.
(BIM: What is usually understood by that?)

2.3 Software for designing building information model.

There are a lot of programs for BIM design. For example:

- ArchiCAD was created in 1984, the first name was Radar CH and used for designing water systems. Now it is a popular software for architectural design of the building.

- Revit was created in April 2000. On 04.04.2002 the company Autodesk bought Revit Technology Corporation after that the program was renamed to Revit Building in 2005. In April 2007 Revit Architecture was created for architectural design. The program Revit Structures was created on 07.06.2006 for structural design and the program for MEP design was created in April 2006 – called Revit MEP
- Tekla Structures – modern tool for structural engineers, used for designing
- Tekla BIMsight – software for viewing building information model in native Tekla format or in .ifc (Industry Foundation Classes It is an object-based file format with a data model developed by buildingSMART)
- Solibri Model Viewer – also for viewing building information model

Some programs also can be used in mobile version that helps to visualise building structures and improve quality of works on site.
(https://en.wikipedia.org)

2.4 Roles and responsibilities

There are three functions in BIM process (Figure 3):

- Management
- Strategic
- Production

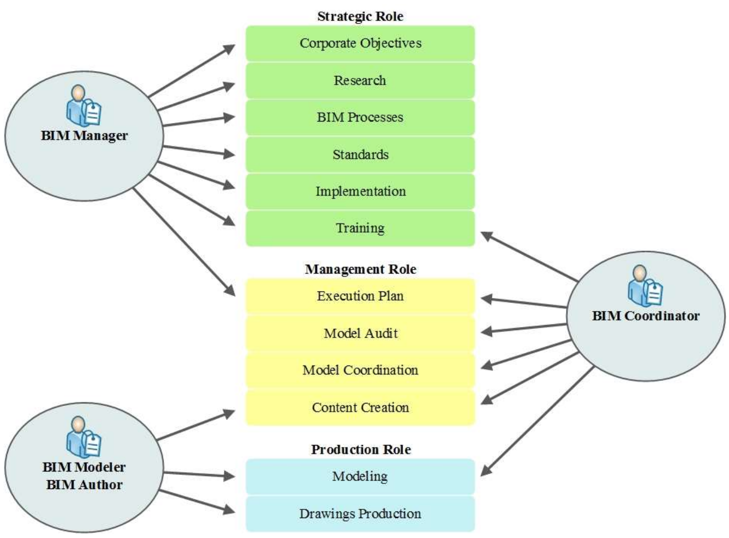

Figure 3. Roles in BIM project (Template of Autodesk Corporate BIM standard for Building/Construction Projects)

Strategic function

The manager is responsible for the implementation of this function.

His basic professional duties are:

- Creation and implementation of the corporate strategy of BIM
    - Best practice / research
    - Creating BIM processes, and also industrial, administrative, or other processes through which a piece of work passes from initiation to completion
    - Elaborating and supporting BIM standards
    - Implementation of BIM to the company working processes
    - Development of training strategy

(Template of Autodesk Corporate BIM standard for Building/Construction Projects)

Management function

BIM Manager and/or BIM Coordinator are responsible for the implementation of this function.

The main responsibilities of this role are:

- Fulfillment of BIM Plan
- Controlling the correct use of information and principles of modeling
- Involvement in the interdisciplinary adjustment meetings
- Quality control of content, including its development and advancement

Every project needs BIM Coordinator to assistance establish the project, control the model and accommodate with all participating employees.

(Template of Autodesk Corporate BIM standard for Building/Construction Projects)

Production function

For the effective implementation of this function are responsible BIM Authors - the designers, which are creating different parts of the project with aptitudes and relevant experience in working with BIM software.

Information creation is the main responsibility of this function. BIM experience is not significant to create the model but technology skills are. Consequently, all the employees should have the appropriate professional skills.
(Information from Template of Autodesk Corporate BIM standard for Building/Construction Projects)

2.5 Forms of output information from the model

Information model of the building today is a specially organized and structured set of data from one or multiple files, allowing output information as a graphic and any other numeric representation which is suitable for future use by different software for design, calculation and analysis of the building and all its components and systems.

Building information model as an organized set of data about the object is used directly by the program in which it was created. But for experts it is also important to take the information from the model in a convenient way and use it wider in their professional activity outside a particular BIM-program.

(BIM: What is usually understood by that?)

This raises another important task of information modeling – to provide the user with information about the object in a wide range of formats, technologically suitable for further processing by computer or other means.

Therefore, the modern BIM-program suggests that the information about the building contained by the model can be obtained in a large range of species for external use.

These generally recognized forms of output information from Building information model include:

1. 2D and 3D drawings;
2. 2D files and 3D models for use in a variety of CAD-programs
3. Tables, lists, specifications;
4. Files for use in the internet;
5. Files with engineering task for producing components and structures;

6. Files-orders for the supply of equipment and materials;
7. Result of special calculations;
8. Videos, showing the simulated process;
9. Files with data for calculations in other programs;
10. Files with visualization and animation (Figure 4),

Figure 4. Project of the center of modern arts in Revit Architecture. (Elena Covalenko, project work, NUACE, 2009)

11. Special sections, fragments of the building;
12. Files for 3D printing;
13. Any other kind of information that can be required for the design, construction or operation of the building

All these forms of output information provides the universality and effectiveness of BIM as a new approach in the design of buildings and ensures the main position in the architectural and construction industry in the near future.

3 The actual situation with BIM in Russia

Nowadays BIM technology becomes more and more actual in Russia. A lot of companies started to implement BIM in their organization system. It is a difficult process especially for big companies because it is a complex reorganization of all existing processes, there is a need of new specialists or a need in studying of employees.

Russian Ministry of construction started realizing the plan for phased implementation of BIM technologies in the civil and industrial constructions. This plan was signed on 29 December 2014 and consists of the following steps:

- Selection and sending to the experts the pilot projects, the design of which was made with the use of BIM. Must be done by March 2015
- Making expert evidence according to the project documentation. Must be done by April-November 2015.
- Analysis of the project documentation and expert evidence of the project that was designed with the use of Building Information Modeling technologies by the Russian Ministry of construction
- Making corrections in regulatory enactments, engineering regulations and educational standards. Must be done by December 2016
- Preparing specialist who will use Building Information Modeling in the civil and industrial constructions and experts who will check this kind of projects. Must be done by December 2017

Now the Russian Ministry of construction is making corrections in regulatory enactments, engineering regulations and educational standards.

On 18 December 2015 the company Autodesk presented a pattern of the open BIM-standard for design of the building and infrastructures. This document was created by:

- Neboysha Novkovich, from the company - Konkurator
  Senior Consultant at the Technical Solutions Department
  Autodesk Certified Trainer

- Sergey Benklyan, from the company Konkurator
  Senior Project Manager

- Igor Rogachev
  Autodesk Certified Instructor
  Autodesk Elite Expert
  Autodesk Civil 3D Certified Professional

- Ilya Yemelyanov, from the company Autodesk Consulting
  Technical Consultant, AEC Solutions

- Petr Manin, from the company WERFAU
  Head of BIM Department
- Alexander Popov, from the company WERFAU
  BIM Coordinator

(Information from: Corporate BIM standard for Building/Construction Projects)

This standard has the main objectives:

- To store and adjust the best world processes in BIM standardization for practical use in the Russian Federation.
- To increase maximally the production efficiency through accepting a coordinated and consistent approach to working in BIM.
- To establish the standards, settings and practices that guarantee delivery of high quality data and uniform drawing output across an entire project.
- To guarantee that digital BIM files and folders are formed correctly to permit efficient sharing of information when the working process is going on in a mutual atmosphere.

The standard features the information modeling technologies application to the following BIM uses:

- Development, adjustment, acceptance and disengagement of design documentation on the basis of BIM models.
- Interdisciplinary adjustment of extensional solutions and recognition of conflicts by component the aggregated models.

- Interpretation and visual control of the BIM-based design decisions.

(Template of Autodesk Corporate BIM standard for Building/Construction Projects.)

4 The actual situation with BIM in YIT Saint-Petersburg

4.1 Short history

YIT's story begins in 1912, at the Helsinki branch office established by the Swedish company Ab Allmänna Ingeniörsbyrån in the then Grand Duchy of Finland. The company's goal was to enter the Russian market through Finland. The year 1997 saw YIT's expansion into Russia, when the company acquired the St. Petersburg-based construction company ZAO Lentek. Instead of construction projects, the acquisition allowed YIT to concentrate on housing development and plot acquisitions in Russia. By 2008, YIT had become the largest foreign building company in Russia. In addition to St. Petersburg, housing construction expanded and came to include Moscow, Yekaterinburg and Rostov. In 2010, YIT acquired a small Slovakian construction company, with the objective of becoming a major housing construction company in the countries of eastern Central Europe, alongside Russia and the Baltic countries. YIT is pursuing well-managed and profitable growth in all businesses in Finland, Russia, the Baltic countries and Central Eastern Europe. In 2014, the revenue amounted to around EUR 1.8 billion. YIT operates in eight countries and has nearly 6,000 employees. (http://www.yitgroup.com/YIT_GROUP/about-us/YIT-in-brief/history)

4.2 BIM in YIT Saint-Petersburg

The company YIT Saint-Petersburg started to use building information modelling recently. The first architectural model of the 7th storey apartment house was made according to the existing drawings from the project documentation and used for volume calculation by estimation department.

Figure 5. BIM model of the 7th storey apartment house (“YIT Saint-Petersburg”, Building Information Model of the object “Novoorlovsky, stage 1.6.1”)

Now the company start to think about implementation of BIM in their future projects because it will decrease mistakes in designing, reduce project duration, increase profit and make communication between designer and contractor better.

The first step is to create a technical task for the designer, to decrease rising of the cost for BIM model. Because if there are no requirements to model the designer will make the model how he wants. Then the contractor will pay additional money for making changes in the model according to his needs.

To avoid that case, the decision was made to make one technical task for the designing of BIM for all projects.

5 Technical task for designing BIM model

5.1 Content of the technical task

During the practice in YIT Saint-Petersburg the author had a purpose to make a technical task for designing of BIM model, which will include:

- Work stages and information delivery.
- Minimum requirements for the number of modeled design disciplines and depth of modeling (for each discipline).
- Requirements for the level of development (LOD) for each element of each stage and discipline.
- Requirements for classification system of the elements
- Requirements for the content and format of design output.
- Requirements for the approval and change procedures
- Requirements for the file exchange format and used programs

The technical task was created according to the needs of engineers, project managers and estimators.
Tables with Level of Development (LOD) specifications are based on tables from Autodesk BIM Standard for Building projects.
The full technical task is presented in the appendix.

5.2 General information

The first part of the technical task consists of general Building Information Modeling terminology. This information was added for common understanding of terms by the designer and the client. Terms were taken from Template of Autodesk Corporate BIM standard for Building/Construction Projects.

5.3 General requirements for Building Information Model

The second part of the technical task consists of general requirements for Building Information Model which were not included in other paragraphs. Also this part consists of requirements for checking the model, such as:

- checks of the spatial position and geometrical parameters,
- checks of data,
- 3D coordination checks.

5.4 Stages of work and control point of information issue

The third part of the technical task includes the development stages of Building Information Model and requirements to output information. On project and work documentation stage the model is given in 2 phases: Model without MEP (General plan, Architectural design and Structural design) and the second phase – it is a full model with all engineering systems.

This is needed for the estimation department, because they are making calculations without an engineering system and it is important to have a model without MEP.

5.5 Requirements to the level of development (LOD) for each phase

One of the main parts of the technical task is the requirements to the level of development for each element for each phase. This paragraph was developed with the help of engineers and project managers. The tables with Levels of Development was taken from Autodesk BIM Standard for Building projects and was upgraded according to engineers and project manager needs.

These tables also include the requirement of Russian Governmental Regulation number 87 from 16.02.2008 called About content of project documentation and requirements to its content.

5.6 Requirements for the system of classification for elements

This paragraph was created according to the estimation department needs. For estimation they use the program Quintet and Building Information Model should satisfy the special classification system.

5.7 Other requirements

Also the technical task includes requirements for composition and output formats of the project results, requirements to coordination procedures and making changes and requirements for software. These requirements are needed because the problems can be with viewing the model, for example: the client does not have software which was used by the designer, or the model cannot be open in the previous version of the program.

6 Conclusions

Building Information Modeling is a modern tool which can improve the quality of the building projects on all stages

BIM helps to:

- Reduce rework
- Reduce overall project duration
- Reduce mistakes and errors
- Reduce cost of the project

(According to Smart Market Report “The Business Value of BIM in North America”)

The figure below shows that implementation of BIM can improve the quality of the project practically in all directions.

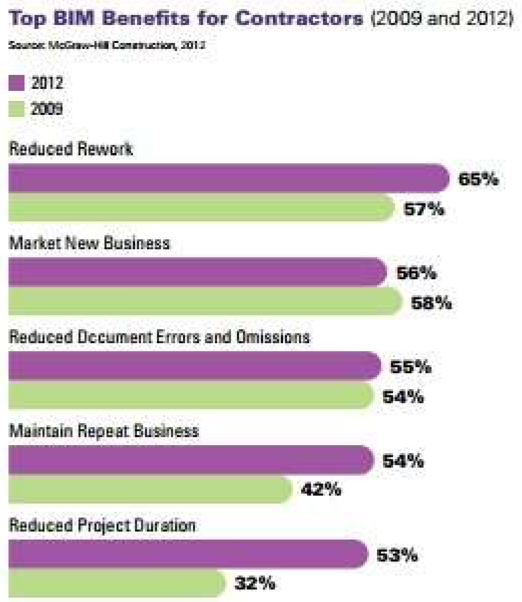

Figure 6. Top BIM Benefits for Contractors. (The Business Value of BIM in North America, 2012)

In my opinion, to use BIM more effectively in company YIT Saint-Petersburg, the company should start the process of partly implementation of BIM by phases. The first phase has already been done – the first BIM-models were designed for the estimation department according to the existing drawings.

The second phase is to educate engineers and project managers to use the software for designing and viewing Building Information Model. This phase has partly been realized – engineers and project managers learned the basics of BIM.

The next phase is to find an experienced designer who will make projects in BIM software on a professional level without mistakes. In my opinion, it is hard because of a small amount of designers who make really good projects. On this stage also OpenBIM can be used system because it can reduce mistakes and make better cooperation between designers and the contractor.

The next phase is implementation of BIM on site. All workers on site also should be taught to use BIM. It will make the construction process more convenient, effective and faster because there will not be need for a huge amount of drawings on paper, for construction process will be need a tablet with special program for viewing BIM model in .ifc format. BIM on site can also make the system of delivering drawings on site more easily. Now the system is the following:

1) The designer sends work documentation to the project manager
2) Engineers check these drawings
3) The project manager stamps all drawings - “to work produce”
4) Then the documentation with stamp is downloaded on special resource SokoPro
5) The designer prints documentation with stamp and sends it to the site.

With mobile software for tablet the BIM model which was approved can be opened directly from SokoPro.

All these phases will help to use Building Information Model more effectively.

Figures

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Technical task for designing Building Information Model

1. General information

Building Information Model (BIM Model): Digital representation of physical and functional characteristics of the construction object serving as a common knowledge base during its lifecycle (design, construction, operation and modernization).

A BIM model in a native format is a 3D representation of the construction object, where every element is linked to the model database and element's 2D image in views/drawings. If an element (or its associated information) is modified in a model, the modification is reflected in the database and in views/drawings.

BIM Project: Design of the construction object created using Building Information Modeling (BIM) technology.

Level of Development (LOD): The level of development of a building information model (BIM) element. LOD sets the minimum amount of geometric, spatial, quantitative, as well as any attribute information necessary for modeling at a particular stage of the construction object life cycle. Thus, LOD consists of two components: a geometric LOD (G) and an attributive LOD (I).

Attribute Data: object information that can be represented in the alphanumeric form.

IFC: Industry-standard open and versatile format for BIM data exchange.

RVT: Basic Autodesk Revit model file format.

PLA: Basic ArchiCAD model file format.

ID: The ID of the object in the project, which the user can change at any time, from any object. The user ID is alpha - numeric combination. Software sees all created objects and distinguish them by ID.

2. General requirements for Building information model

BIM-model must faithfully reflect the original data for the design.

Detailing BIM-model for the design stage (Sketch, Project documentation, Work documentation) shall comply with the details of each stage of the project (paragraph 4) and the general requirements, which are issued at the beginning of the design as part of the Internal technical requirements and defined by technical task for the design

BIM-model should be divided by stage of construction or buildings in accordance with the requirements of the customer

The parameters and attributes of building structures must comply with design solutions

Such details as hydro and insulating layers, finishes (alignment coating, cladding) may be present as the attributes of the main of the building element.
The objects of landscape design, furniture, equipment and similar elements, whose physical volume in estimate will be determined by the unit "piece / set / party" in the model can be represented without exact match to drawings and three-dimensional detailing, but the properties of these objects should include information such as name, type, material.

Before providing BIM-model to the customer, the designer must check it in the following areas:

- checks of the spatial position and geometrical parameters,
- checks of data,
- 3D coordination checks.

Checks of the spatial position and geometrical parameters shall include:

- Verification of model elements’ compliance with the LOD requirements (geometric component). Excessive and insufficient levels of development are identified.
- Checking for conformity between the coordinate system and the base file.
- Checking the accuracy of model elements (analysis of elements’ junctions).
- Checking the absence of duplicated and overlapping elements.

Checking of data is needed to determine to what extent the data is systematized, classified and structured in accordance with the requirements of this standard and a specific project.
Checking for spatial conflicts shall be performed in order to find and resolve any potential collisions between model elements in the design phase, thus preventing them on site.

3. Stages of work and control point of information issue

<u>-Sketch</u>

Building Information Model in accordance with the requirements to the LOD in the native format and .ifc

<u>-Project documentation</u>

The result of the work is given in 2 phases.

Separate:

- General plan + architectural design + construction in the native format and .ifc
- Building Information Model in accordance with the requirements to the LOD in the native format and .ifc

<u>-Work documentation</u>

The result of the work is given in 2 phases.

Separate:

- General plan + architectural design + construction in the native format and .ifc

Building Information Model in accordance with the requirements to the LOD in the native format and .ifc

4. Requirements to the level of development (LOD) for each phase

All elements for the “Project” and “Work” phase should include requirements to the level of development for previous stage (For example^ LOD 400* should include requirements to LOD 300* and LOD 200*

LOD matrix for Heating Systems

Components	Sketch	Project documentation (Stage P)	Work documentation (Stage W)
	LOD 200*	LOD 300*	LOD 400*
Equipment	Type, approximate geometry, location	Exact dimensions, labeling, manufacturer, part name	Exact visual representation, fittings/ accessories, mass, power consumption, power
Pipes		Type, exact dimensions, location, material, labeling, manufacturer, part name	Power consumption, pressure
Fittings		Type, exact dimensions, location, manufacturer, part name, part number	Exact visual representation, fittings/ accessories, labeling
Connections		Type, exact dimensions, location, material, manufacturer, part name	
Isolation		Type, exact dimensions, location, material, manufacturer, part name	

LOD matrix for Ventilation Systems

Components	Sketch	Project documentation (Stage P)	Work documentation (Stage W)
	LOD 200*	LOD 300*	LOD 400*
Air outlets		Type, exact dimensions, location, labeling, manufacturer, part name	Exact visual representation, fittings/ accessories, power consumption, velocity
Ductwork		Type, exact dimensions, section/ profile, location, material, labeling, wall thickness, manufacturer, part name,	power consumption, velocity, pressure
Air tubes		Type, exact dimensions, section/ profile, location, material, labeling, manufacturer, part name	Power consumption, velocity, pressure
Fittings			Type, exact dimensions, location, manufacturer, part name, part number, exact visual representation, fittings/ accessories, labeling
Equipment	Type, appr. geometry	Exact dimensions, location, labeling, manufacturer, part name, mass	Exact visual representation, fittings/ accessories, power

			consumption, fireresist
Isolation		Exact dimensions, location, material, mfg, part name	Fireresist

LOD matrix for Water Supply, Drainage and Sewage Systems

Components	Sketch	Project documentation (Stage P)	Work documentation (Stage W)
	LOD 200*	LOD 300*	LOD 400*
Equipment	Type, approximate geometry, location	Exact dimensions, labeling, manufacturer, part name, mass, power consumption, power	Exact visual representation, fittings/ accessories
Pipes		Type, location, material, labeling according GOST. Also give scheme for removing drainage from air conditioners	manufacturer, part name, exact dimensions, power consumption, pressure
Fittings		Type, exact dimensions, location	Exact visual representation, fittings/ accessories, labeling, manufacturer, part name
Connections			Type, exact dimensions, location, material, manufacturer
Isolation		Type, location, material,	Labeling, manufacturer, exact dimensions

LOD matrix for Electrical Systems

Components	Sketch	Project documentation (Stage P)	Work documentation (Stage W)
	LOD 200*	LOD 300*	LOD 400*
Lamps		Type, approximate geometry, location, labeling, Manufacturer, Power	Exact dimensions, exact visual representation, fittings/ accessories, part name, part number
Switches		Type, approximate geometry, location	Exact dimensions, exact visual representation, fittings/ accessories, labeling, manufacturer, part name, part number
Switchboards		Approximate geometry	Exact visual representation, fittings/ accessories, part name, part number, mass, Exact dimensions, labeling, manufacturer
Equipment	Type, approximate geometry, location	Labeling, manufacturer	Exact visual representation, fittings/ accessories, part name, part number, mass, power
Cable trays	Location, approximate geometry	Type, exact dimensions, section/ profile	Exact visual representation, labeling, manufacturer, part name, part number
Cables		Type, exact dimensions, section/ profile	Accurate size, location
Grounding bar	Location, approximate geometry	Type, exact dimensions, section/ profile	Exact visual representation, material

LOD matrix for Structural Design

Components	Sketch LOD 200*	Project documentation (Stage P) LOD 300*	Work documentation (Stage W) LOD 400*
Foundation	Types, approximate geometry	Exact dimensions, sections, connections, junctions, characteristics of materials, the volume of concrete, weight of the reinforcement.	Exact dimensions of the foundation, components, parts, specifications, list of details
Piles	Types, approximate geometry and location	The exact number, length, cross section. The manufacturing method (technology). Characteristics of materials. Volume of the concrete, weight of the reinforcement.	Components, parts, specifications, list of details
Wall / column	Types, approximate geometry, location on the plans.	Exact dimensions, sections, connections, junctions, characteristics of materials, the volume of concrete, weight of the reinforcement, fire rating	Exact dimensions, details, specification, list of details
Deck / roof	Types, approximate geometry	Exact dimensions, sections, connections, junctions, characteristics of materials, the volume of concrete, weight of the reinforcement, fire rating	Exact dimensions, details, specification, list of details

Beam / Rafter/ Truss	Types, approximate geometry	Exact dimensions, sections, connections, junctions, characteristics of materials, the volume of concrete, weight of the reinforcement, fire rating	Exact dimensions, details, specification, list of details
Stair case	Types, approximate geometry	Exact dimensions, sections, connections, junctions, characteristics of materials, the volume of concrete, weight of the reinforcement, fire rating	Exact dimensions, details, specification, list of details, manufacturer, part name, part number
Elevator shaft	Types, approximate geometry	Exact dimensions, sections, connections, junctions, location, mass	Exact dimensions, details, specification, list of details, manufacturer, part name, part number
The opening / Holes	Approximate geometry	Exact dimensions, Location, Labeling	Construction, fittings/ accessories
Junctions / embedded details		Type, approximate geometry, material, labeling	Exact dimensions, exact visual representation, section/ profile, structure, manufacturer, part name, part number, mass
Bracing / Connections/ land cofferdam / studwork	Approximate geometry	Type, exact dimensions, section, location, material, labeling, mass	Exact visual representation, section/ profile, structure, manufacturer, part name, part number, fire rating

LOD matrix for Architectural Design

Components	Sketch	Project documentation (Stage P)	Work documentation (Stage W)
	LOD 200*	LOD 300*	LOD 400*
Wall	Wall type Precise dimensions, location, orientation	Exact visual representation, structure, material, slope, labeling, fire rating	Manufacturer specific details, part name, part number
Deck	Deck type, Quantity, size, shape, location and orientation	Exact visual representation, structure, material, slope, labeling, fire rating	—
Floor	— —	Type, exact dimensions, exact visual representation, construction of floor in layers with precise external dimensions	Manufacturer specific details, part name, part number
Column	Column type, precise dimensions, location	Exact visual representation, section/ profile, construction, material, space, labeling, precise dimensions	—
Ceiling	— —	Ceiling type, approximate geometry, exact dimensions, exact visual representation, construction, location, material, slope, space, labeling, manufacturer	Part name, part number
Window	Approximate geometry Type, location	Exact dimensions, exact visual representation, frame and sash, fittings/ accessories, material, labeling	—
Door	Approximate geometry	Exact dimensions, exact visual representation,	—

	Type, location	frame and door leaf, handle, material, labeling, manufacturer, fire rating	
Staircase	Approximate geometry Location	Type, exact dimensions, construction, material, slope, labeling	—
Staircase	Approximate geometry Type, location	Exact dimensions, construction, material, labeling	—
Handrails	Approximate geometry Type, location	Exact dimensions, exact visual representation, construction, location, fittings/ accessories, material, labeling	Section/ profile, manufacturer, part name, part number
Heavy facade	Approximate geometry —	Type, exact dimensions, exact visual representation, detailed construction, location, fittings/ accessories, material, labeling	Section/ profile, manufacturer
Impost	Approximate geometry —	Type, exact dimensions, exact visual representation, construction, location, material, labeling	Section/ profile, manufacturer
Roof	Approximate geometry Type, location, Space	Exact dimensions, construction, material, slope, labeling, fire rating	—
Plumbing fixtures	Approximate geometry Location	Type, exact dimensions, exact visual representation, fittings/ accessories, labeling	Part name, part number
Light facade	Approximate geometry —	Type, exact dimensions, exact visual representation, detailed	Section/ profile, fittings/ accessories, manufacturer, part name, part number

		construction, location, material, slope, labeling	
Entrance ramp	—	Type, exact dimensions, construction, location, material, slope, labeling	Section/ profile
Room	Approximate geometry Type, area	Exact dimensions, labeling	—

LOD matrix for General Plan design

Components	Sketch LOD 200*	Project documentation (Stage P) LOD 300*	Work documentation (Stage W) LOD 400*
Borders of the site	The exact dimensions, the red line, building border	------	------
Excavation for foundations / pit	Rough excavation (foundation not included) is displayed as a 2D surface (plane) with a bottom reference point which is average for the area. Connection to the existing surface is made through the vertical walls or arbitrary near-vertical slopes	3D excavation with foundation cuts and correct outcropping. Foundation cuts have vertical walls or near-vertical slopes. Surface inside the excavation is approximate.	Detailed 3D surface with foundation cuts and grading objects. Slope and elevation values are accurate and can be modified; the whole object is then rebuilt accordingly.
Building	Exact dimensions, gridlines		
Landscape gardening	Area, location, exact dimensions	List of gardening, coating plan, part name, part number	Exact location and dimension
Driveways, sidewalks, walkways	Exact dimensions, coating plan	Location of entry constraints, humps, gutters, rainy wells	
Rest areas for children and adults	Location, approximate geometry	List of the objects and equipment with manufacturer, part name and part number. Coating plan of areas, foundations for equipment	
Elements	Location, exact dimensions	List of the objects and equipment with manufacturer, part name and part number. Coating plan of areas, foundations for equipment	

Sites for the temporary storage of household / bulky waste	Location, exact dimensions		
Parking	Location, amount of parking places	Exact dimensions	

5. Requirements for the system of classification for elements

5.1 Location of the original documentation

- Original documentation should be located in the folder “Work sheets”
- Name of each sheet should contain name of the stage and name of the drawing

5.2 Attributes of building structures, such as:

-Name

-Type

-Shape

-Geometry

-Material

-Location

-Construction function

Must conform to accepted design solutions and technical requirements

5.3 Name of the layers must comply to name of the structure (For example: wall, column, stair …)

5.4 Cast-in-situ structures should contain information about the name of the material and its technical characteristic, information about reinforcement. (For example: Cast-in-situ floor structure – 200 mm B 25 F150 W8 y=120кг/м3)

5.5 Unused layers must be removed

5.6 Such elements as windows and doors should have own ID which contain information about material, type, geometric dimensions (For example: ОК-ПВХ 1200x1500

5.7 Every type of doors should have own ID according to their classification:

- External door, metal, glazed
- External door for technical rooms, metal
- Internal doors for public places, metal
- Internal flat doors, metal
- Internal doors for public places, wooden
- Internal interior doors, wooden

6. Requirements for composition and output formats of the project results

Designer should provide full Building Information Model in next formats:

- .ifc
- Native format from designer programm (For example: .pla -ArchiCAD, .rvt - Revit)

7. Requirements to coordination procedures and making changes

- *Make dividing of the model by stages/buildings/sections/floors according client needs*
- *Provide a test part of the model for matching*
- *The final model should contain changes which was made during designing*

8. Requirements for software.

Discussing separately

9. Software for viewing model

Tekla BIMsight