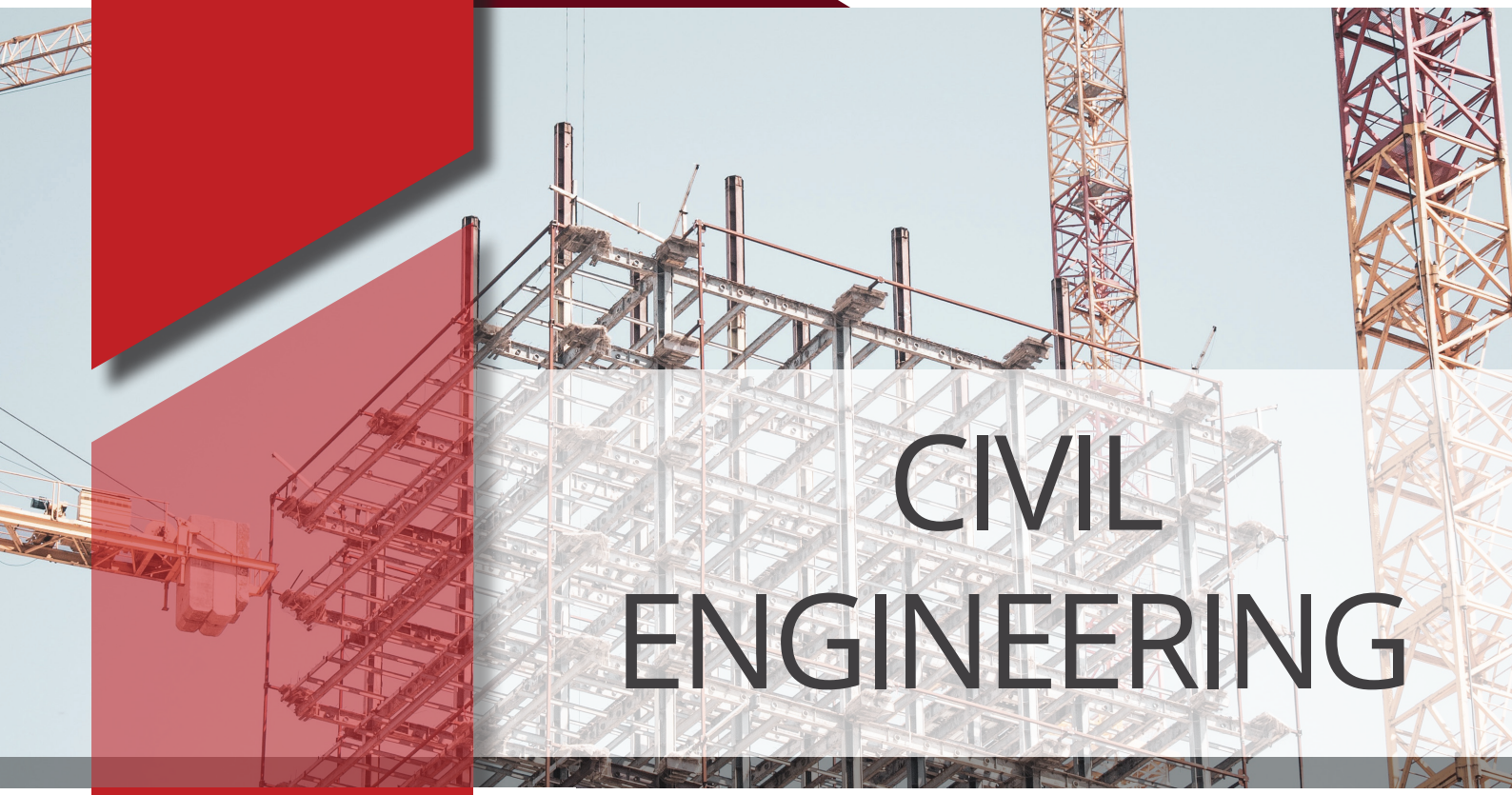
Interreg

EUROPEAN UNION

Austria-Czech Republic

European Regional Development Fund



CIVIL ENGINEERING

Building information management

UNIVERSITY OF APPLIED SCIENCES UPPER AUSTRIA

VŠTE

EUROPEAN UNION

CONTENTS

1. INTRODUCTION TO BIM IN TERMS OF MANAGEMENT

Definition: BIM is a digital representation of the physical and functional characteristics of the building. BIM is a source of shared building information, providing a reliable basis for decision-making throughout its lifecycle, from the initial plan to its disposal.

1.1. 3 BIM (Modeling)

Introduction to Building Information Modeling (BIM)

- basic BIM characteristics
- BIM concept
- the difference between the 3D model and the BIM model
- benefits of the BIM model in each phase of the construction
- coordination of professions in BIM
- BIM as a communication tool

Information modeling processes

- BIM Project Execution Plan
- industrial Foundation Classes (IFC)
- BIM Management BIM => Building Information Management

„BIM is an organized approach to collecting and using information across the project. At the heart of this effort lies a digital model containing graphic and descriptive information about the design, construction and maintenance of objects.“

(BIM TASK GROUP, 2012)

„Building Information Modeling (BIM) is a digital representation of the physical and functional properties of a given object. BIM is a shared resource of knowledge of object information that forms a reliable basis for decision-making throughout its lifecycle; defined as an existing form from the original concept of demolition. "

(NATIONAL BIM STANDARD, 2014)

„Building Information Modeling (BIM) is an intelligent process based on 3D modeling that equips architects, engineers and construction professionals with a look at the issues and tools to efficiently plan, design, construct and manage buildings and infrastructure." (AUTODESK, 2016)

DEFINITION FOR PURPOSE OF THIS COURSE:

„Building Information Modeling can never really be just technology, software, or 3D object modeling. It requires knowledge and understanding of a number of abstract modeling concepts. Additionally, it goes beyond mere technology and BIM can be considered as a method for creating almost non-redundant (where each information, each fact is included only once) of a model of any construction or building component. Such a model is sufficiently described to be able to carry out life-cycle simulation before its actual transformation into physical reality.“

1.2. BIM Basic Characteristics:

BIM Model

- information database - contains complete BLC data (= Building Life Cycle)
- results from all participants in the process
- collection and subsequent use of data -> without data loss and misinformation

Model BIM = genetic code of the building

- since the second half of the 1980s
- classification of BIM objects
- representation of knowledge about properties and boundary conditions
- assembly algorithms => simpler object tracking

BIM concept

- BIM represents technological progress and shift
    - targeted work with information
- coordination processes - correct use, efficiency
    - data exchange,
    - collision detection,
    - adjustments of parameters etc.
    - classic modeling (2D, 3D)
        - unstructured information
        - inconsistency and difficult handling of data
    - reduced design efficiency

Benefits of BIM Modeling:

- improving communication
- cost savings
- solution variants
- the quality of the work
- control of the construction process
- transparency
- availability of information,
- simulation => Improved environmental impact

Virtual equipment construction - goals:

- uncertainty
- safety
- problems

1.3. Simulation and impact analysis

The BIM model represents:

- knowledge of objects
- their behavior and
- knowledge of other properties → BLC (Building Life Cycle)
- structured and unstructured knowledge:
    - the needs and requirements of users and investors
    - historical experience
    - the need to perform object revisions
    - Another benefit of BIM is the possibility of creating a system for managing and collecting knowledge and managing it over time.

1.4. The difference between the 3D model and the BIM model

3D = BIM base

Difference - in entities used:

- tools + elements
- 3D model geometry – by folding:
    - spatial points, edges, surfaces or general bodies
- BIM model - originated in element modeling → define other properties
    - e.g. material, producer, price and more
- BIM model modeled with a hierarchical structure
    - allows you to precisely locate the element
    - provides information about the room, the floor, the building, the land
    - is usable for example for topological analysis of a building design.

2. BASIC ORIENTATION IN BIM - LONG-TERM BENEFITS

2.1. Introduction

- Construction is a strategically important sector for the economy of each country in terms of production, job creation and construction and maintenance of the public space.
- One of the least digitized sectors with a stagnant rate of labor productivity - systemic weaknesses in the level of cooperation, poor management of information and lack of investment in technology, research and development, low efficiency of public finances and higher financial risk due to possible unforeseen expenditure overruns, public infrastructure and additional changes to the building documentation.
- BIM = an effective tool for fulfilling the principles of sustainable construction throughout the building's life cycle.
- Construction 4.0 (Industry Revision 4.0) = digitization
- BIM - the global language in the construction industry (cross-border cooperation)
- The EU responds to the BIM trend in order to maintain competitiveness.
- In 2014 EU acknowledged the usefulness of BIM for the public sector (the possibility of requesting BIM in public procurement)
- More and more European governments and public sector organizations are setting up programs to support the wider use of BIM at national and regional levels.

2.2. What is BIM?

- is not pure technology
- BIM model = a database of information that may include complete data from the initial design through the construction, management of the building and eventual alteration of the completed buildings (reconstruction) to their demolition, including the ecological destruction of the site and the restoration of the site
- BIM model is NOT a 3D model

- BIM - Rules for handling information

- a common data environment
  - = CDE (Common Data Environment)

2.3. Long-term benefits of using BIM

- Transition to BIM is associated with a change in current processes, especially in terms of communication, transmission and data sharing.

- The second area of change is the introduction of new technologies that enable BIM models to create, utilize and effectively promote change in communications and processes throughout the life cycle of a building.

- The third important area is BIM's contribution to sustainable construction and complex building quality.

- The investment embedded in the creation of a complex multidimensional model is more efficient than ever with existing solutions due to its wider distribution over time.

- savings in costs and time calculated over the life cycle of the building;

- improving communication between building process participants;

- improving the control of the building process;

- improving the quality of the resulting work;

- preventing collisions and misunderstandings when working with information generated by using old versions;

- increasing transparency and improving access to information in decision-making at different stages of the life cycle of a building;

- the real possibility of continuously integrating all the required professions during the design phase of the project (e.g. budget manager, building manager);

- environmental protection with an emphasis on energy savings (reducing the energy performance of buildings) thanks to simulation possibilities at the stage of project preparation and use of data in the event of a change in the completed construction (reconstruction) or its removal;

- easier processing of variants;
- streamlining the economic management of buildings (projects), from initial calculations, through selection and ongoing calculations to invoicing itself;
- significant backgrounds for the design, installation, operation and replacement of equipment;
- availability of up-to-date information in one place;
- supporting the development of the national infrastructure database for spatial information

Estimated cost savings over the life cycle of the building:

Public works contracts in the Czech Republic in 2015 (total data for 2016 were not available at the time of the Conception was available) amounted to CZK 118.7 billion per year (source: Public Tenders Information System). The savings of 20% would be about CZK 23.7 billion per year in the case of public construction contracts. This saving is an optimistic option for the savings expected in the BIM implementation of public procurement. This is in particular to reduce the risk of additional costs due to items not included in the budget.

3.GENERAL ISSUES OF WORKING WITH BIM

3.1. Use of BIM in the ordering, design, implementation and operation/management of buildings

Investor

- the possibility of controlling the project and its costs in all its phases
- faster integration of requirements and changes
- essential information for decision making is available at an earlier stage
- easier communication with other participants
- possibility to improve the quality of buildings thanks to SW validation of parameters and properties of used building materials, structures and products and their compliance with applicable standards

Designer / Principal Designer (Architect, Engineer, Technician)

- more convenient tools for work
- easier modification of the design based on the requirements of the builder, statics etc.
- easier creation of variants
- fast visualization (no need to recreate the 3D model)
- fast response from statics to design options
- fast energy analysis
- a smooth transition from a conceptual model to a specific one
- elimination of the risk of structural collisions

Building components designer

- easier communication with the designer / master planner regarding a model
- easier to incorporate changes
- easier communication with the builder

HVAC Designer and of technological parts of buildings

- easier communication with the designer / main designer, static and designer of the building part over one model
- easier to incorporate changes
- easier communication with the builder

- savings in creating an analytical model
- the option of a variant solution
- possibility of energy simulations

Statistician

- easier communication with the designer/main designer and designer of the building component over one model
- easier to incorporate changes
- easier communication with the investor
- savings in creating an analytical model

Technical and copyright supervision

- easier real-mode checking of the BIM model
- easier communication with other participants
- better ability to record modification and change requests
- reducing the risk of bad information transmission

Budgetary

- time saving thanks to automatically generated data for creating an inventory of construction, supplies and services, including change management
- constant access to up-to-date information - more accurate budgeting
- the possibility to quickly create cost options for decision making

Contractor

- access to always up-to-date documentation
- easier communication with designers of individual professions over one model
- checking compliance with the time schedule and financial plan
- reduction in the number of collisions during construction
- preparation of prefabrication
- easier and clearer breakdown of the supplies and work carried out by the subcontractor, their coordination and control
- refining the ordering of materials and thus lower waste production
- closer data logging for financial controlling (plan x fact)
- fast classification of individual building elements due to their easier visualization in the model

Facility manager

- actual building model filled with information on individual building products and elements, including the supplier and information on their maintenance
- simple reporting of building products and elements, etc.

- option to extend the model for specific FM data
- simplified decision making in the operation, maintenance and alterations of the completed construction

Public administration

- same benefits as are valid for the investor
- the possibility of automatically checking compliance of the design with the requirements of mandatory regulations
- more efficient use of public funds
- reducing the risk of cost overruns in public works contracts
- increasing the transparency of construction projects
- simplification of the energy performance of the building and optimization of energy efficiency
- the possibility of linking different construction-related government registers to better infrastructure planning
- simpler and more reliable communication and presentation of intentions in public deliberations
- supporting the development of the national infrastructure database for spatial information

Building certification

- savings in creating an analytical model
- possibility of automatic checking of some aspects of the model
- easier quantification and more effective assessment of some aspects of the sustainable construction concept

3.2. Specifics for transport structures and other types of infrastructure and special constructions

Modeling of buildings using suitable SW in more than two dimensions is a way of work known to a number of design offices, geodetic companies and contractors.

On top of major projects, this method achieves higher efficiency for the preparation of documentation of construction, lower number of errors and preparation of documents for geodetic works and automation of construction processes.

4. FROM 3D MODELS TO BIM MODELS

4.1. The difference between the 3D model and the BIM model

3D = BIM base

Difference - in entities used:

- tools + elements
- 3D model geometry – by folding:
    - spatial points, edges, surfaces or general bodies
- BIM model - originated in element modeling → define other properties:
    - e.g. material, producer, price and more
- BIM model modeled with a hierarchical structure:
    - allows you to precisely locate the element
    - information about the room, the floor, the building, the land
    - usable, for example, for topological analysis of a building design
- BIM improves workflow - moves center of work:
    - from the necessary design documentation
    - to direct and creative creation of building units
- BIM model:
    - the technical documentation is generated directly from the 3D model of the building
    - layout drawing - based on information about individual entities and their display properties.
    - simple 3D modeller: Floor plan generated as a top view of the model

The BIM model is

= Technologically advanced model

- assigning parameters to a particular element according to the level of development
- elements are gradually modified and specified by adding parameters to each participant in the building process in one such model
- it means: architectural design → structural analysis → fire safety solutions
- all edits in the ONLY model in real time
- all participants in the building process have access immediately
    - → accept the change.

4.2. BIM model allows

By using the BIM model, errors in building solutions are eliminated

Traditional modeling:

- uses several models
- in the design: conflict of individual professions
    - e.g.: loopholes
- it is necessary to coordinate the solutions of the individual professions and agree on adjustments
    - to inform all participants in the building process of changes
    - → error or non-compliance of individual project documentation parts
- will be reflected in the construction phase

    → redesign the proposal, (feasibility, but also time)
    → more work
    → different demands on building materials

4.3. BIM model helps

- BIM model –can detect collisions of specializations
    - collisions can be generated by software itself
      for example, in the case of a collision of the HVAC nets
- facilitate co-ordination work
    - the human factor could fail in the traditional building design → BIM eliminates the error rate
- structuring of elements and their parameters
    - modification of the model with a time-consuming evaluation of the building
    - useful in finding the right solution in many ways
      e.g. in terms of financial demands or sustainability of the building.
- The only element can be viewed together with a huge amount of information available IMMEDIATELY.

5. BIM AND THE LIFE CYCLE OF BUILDINGS

5.1. Advantages of the BIM model in each phase of the construction/investment process

When designing:

- simplifying communication when modifying the architectural model,
- reducing errors in redrawing drawings, reducing the number of additional requests and resources when submitting documents,
- automatic creation of documentation from the BIM model, possibility to create endless number of cuts and views,
- visualization of the model at any time (no need to create a special model for visualization only)
- creation of basic reports (extract from the database), including area and volume characteristics,
- reduction of errors in documentation updating due to the use of the model as the main source of information,
- the possibility of simulation and evaluation of the behavior of the proposed building (its model) at any stage of the project,
- in the case of the future existence of product catalogues from the manufacturer and clearly defined product classification, the model will offer a better comparison of variants

While construction is in progress:

- better planning of the execution of the construction,
- saving both financial and time resources by eliminating the occurrence of collisions in the design (especially between the different professions of the building process),
- the possibility of designing prefabricated parts (this does not necessarily mean the use of type elements, but rather better planning of the way of production and assembly of both typical and atypical elements),
- reduction of RFI (Request for Information),
- improving communication with the designer

When operating the building:

- updated documentation of the actual execution of the building (the basis for building the models for easier facility management),
- BIM model as a source of knowledge and basis for possible future reconstruction or repair,

- BIM model as a source of planning of the way of demolition and waste disposal

Benefits of the BIM model for individual professions and participants

- the BIM model is processed in 1:50 drawing details
    - that is, the elements with a dimension from bigger than 50 mm are decisive
- More detailed elements - attached as a larger structure specification (3D is expensive)
    - workshop documentation
    - 2D Worksheet developed in 2D
    - parametric model
- changes in parameters, types of materials and other aspects
- you can change the design quickly
    - or analyze again
    - much more design variants with a faster interaction step and consideration of multiple aspects
- BIM is beneficial to structural analysis
    - assigns a specific cross-sections and material
    - the element available in the database of used static software or various auxiliary functions for converting the building model to the calculation model and correctly linking the elements therein
- BIM and HVAC proposal
    - at all stages of the construction process
    - intelligent installation
- BIM and budgeting
    - process - generates reasonably accurate quotation reports and cost estimates
    - the price impact of project changes over time → the impact to be assessed and to avoid later reworking the project
    - a preview of the impact of cost changes of the multi-project and project changes with the potential to save money and time
    - clustering of groups of building elements
    - pricing

- taking into account risks

- BIM and FM (Facility Management)

  - facility manager - at the end of the design and construction process,
  - information model - a rich source of up-to-date information for building management and maintenance
  - clearly structured and automatically processed building information makes significant savings in their operation and construction of new buildings

- BIM and Building Design Certification

  - certification tools
  - e.g. LEEDS, BREAM or SBToolCZ
  - easier iterative evaluation and refinement of results
  - at the same time, it is possible to classify the building elements automatically or semi-automatically → use in the form of structured reports → their easy updating

Benefits of the BIM model for the investor and facility manager

- the BIM model contains data for the entire life cycle of a building (BLC)
- the BIM model data is intended for further use, especially during the use phase
- such a data model can include all the important equipment components of the building, including their specific position and attribute data

Coordination of BIM professions

- BIM offers extensive opportunities for coordination of professions and support for real collaboration on projects
- it is possible to shorten design time by coordinating all participants in the construction process. BIM also allows for a higher quality of the resulting model and thus the whole project as such.

5.2. BIM as a communication tool

- For Team Collaboration
- Combination of different technological tools

  - sharing knowledge
  - shared structures
  - knowledge visualization

        - better orientation
        - navigation in knowledge bases

    - a technique facilitating understanding of shared expertise and experience
    - based on this understanding, take action

- BIM is just a model containing information
- LOD scheme
- BIM as a communication tool or collaboration tool
- someone other than the author of the BIM model extracts from the information model
- unclear conceptual idea → accurate description
- manual drawings → clearly dimensioned lines
- in the past, the information presented in the model could not be considered reliable, as it may not have been accurate.
- the LOD frame, however, allows the model author to state the level of render of the model of the given elements, i.e. their accuracy and thus the reliability

6.INFORMATION MODELING PROCESSES

6.1. Information modeling of buildings

Not just the model
It is about:

- communication
- coordination
- effective cooperation
- managing all processes
    - at the design stage, but
      also at facility management stage.

6.2. Implementation plan for information modeling (BIM Project Execution Plan)

Implementation plan for information modeling

- quality
- prices
- and also time

Created before the start of the entire design process.

- Example: "BIM Project Execution Planning Guide",
- Part of the US National Standard BIM Standard (NBIMS v2)

Information modeling plan:

- identifies individual participants in the construction process
- defines their objectives from the point of view of BIM
- effective exchange of information requires:
- to identify areas of data exchange,
    - details
    - structure
    - technical aspects, including:
    - access to the model, its sharing, division of responsibility, and so on.

6.3. Process map

- describes the individual processes during the design of the building along with the exchange of information between the individual participants
- identification of different types of information and their location in the process of designing the building, information regarding the responsibility for the individual parts of the resulting model.

6.4. BIM Project Execution Plan:

- Ensure that all process participants are clearly aware of the opportunities and responsibilities involved in integrating BIM into the workflow of the project.
- Defines appropriate uses for BIM in the project
    - e.g. design authorization, design control and 3D coordination
    - detailed design and documentation of the BIM process throughout the life cycle of the object.
- The principle of creating a BIM Project Execution Plan is based on the definition of the BIM targets that are achieved through the BIM application.

Industrial Foundation Classes (IFC) IFC = data format

- BIM the only internationally recognized BIM data standard
- Author: IAI (International Association for Interoperability)

Industrial Foundation Classes (IFC) IFC Features:

- Open, publicly available standard
    - ability to create different applications to work with the model
- Possibility of long-term work with data
- It is completely self-sufficient.
- There are no external object libraries required to process it.
    - Information outside of the system can be easily defined by reference.

Industrial Foundation Classes (IFC)

- use of OpenBIM standards (data transfer in IFC)
- so-called Coordination View

- = selection of information that includes:
  definition of spatial structure, building elements and elements of HVAC and fire protection

- This type of information uses most BIM tools (software) when importing and exporting.

Structural Analysis View

- suitable for communication between different analytical tools.
- consists of:
  - load elements, load cases and combinations, curves and surfaces, connections and boundary conditions including material and profile information
- it is independent of the main type of construction

7.BIM – LIFE CYCLE MANAGEMENT

7.1. BIM Management

Building Information Modeling

- significant technology for maintaining and unlocking knowledge, as well as for promoting cooperation between participants in both investment construction and communication throughout the building's life cycle
- in most cases, big number of participants is involved sharing the BIM model
- their cooperation must, however, be organized and managed

Consequently, we can talk about the so-called **Management of Building Information Modeling, or "Information Modeling of Managing Information in Building modeling"**

BIM model = a model that is sufficiently described

- that life-cycle simulation can be performed on it before its actual transformation into physical reality

BIM = supporting tool for:

- execution of construction activities,
- operation of the building
- and use of the building

It is therefore present and utilized throughout the building's life cycle - from design to demolition.

- the term Modeling, as M in BIM Management

7.2. Building Information Management

- management of information sharing

Building Information Management is the process to improve processes.

Level 0

- BIM level 0 is a way of working that has been used for a very long time. Represents the classic 2D drawings in paper form. This is not an unmanaged CAD, most likely

2D, where paper (or electronic paper transfer) is the most used mechanism for exchanging and forwarding documents.

Level 1

- Controlled CAD in 2D or 3D format using the ISO-TS 12911: 2014, ISO 29481-1: 2014 and ISO 29481-2: 2014 standards together with tools to collaborate and exchange data based on a common data environment, preferably based on standard data structures and formats. Commercial data (financial management, costs) are managed separately without further integration.

- Level 1 BIM is assumed to be classic 2D drawings, but created using CAD tools and often transmitted electronically. For the architectural part, 3D information is already present, but the output is usually only visualizations and images used for the presentation of the project.

- If 3D imagery is used for other purposes, it is mostly within large projects and the use itself is very limited to selected tasks, especially in the field of coordination, mostly visual only.

Level 2

- Level 2 BIM has already shifted the use of the 3D model towards greater collaboration, submission of backgrounds, and gaining more insight into the next stages of the construction process. There is a managed 3D environment that fully exploits BIM tools as a standalone methodology with direct access to integrated data. Commercial data is managed through ERP (Enterprise Resource Planning) applications.

- Integration is based on custom interfaces or tailor-made middleware, which can gradually be directed to the expanded BIM. This approach can also work with 4D - program data (such as time consuming) and 5D - the cost of sub-elements, as well as transferring data to other components of enterprise operating systems.

- This level assumes that all participants work in 3D and possibly with other xD information.

It is possible to work in the current fragmented environment, it is not necessary to create the overall model of the building. However, the whole project should be coordinated from one place (BIM manager) and the roles and responsibilities of the individual participants in the entire building project must be precisely defined. For each stage of the process, previous inputs and outputs of the following process phases are defined.

Level 3

- Level 3 BIM is basically a target state that brings the greatest benefits for BIM methodology. At this level, it is already clearly defined to store all information centrally for the entire building (although it will never be a single set). All processes are clearly defined and linked, apart from responsibilities, legal and copyright issues are also solved in the created and managed building model.

- Full integration of data and processes is facilitated by the use of IFC and IFD compliant web services managed by a collaborative model, such as a standalone ontology server. (here in the future we will certainly hear about the so-called Semantic Web - Web 3.0)

- This could be called, for example, iBIM (integrated BIM) with new possibilities to fully collaborate with existing processes of all participants throughout the building's life cycle. At this level, most of the ISO standards for BIM also go.

But BIM Level 3 requires:

- coordination of work processes and team collaboration of participants

- knowledge of product databases and their integration into the BIM model of the building, including all the necessary data

- introduction of new ways of communication and forms of contracts corresponding to the new way of working in a more interconnected environment

- interoperability of used software tools covering not only design, construction, but also operation (4D-time, 5D-price, 6D-FM, ...)

- standardization of basic procedures and used construction data and equipment, facilities

8.BIM – LOD, MEANING FOR STANDARDIZATION

Level of Development (LOD)

- Use of Level of Development
- Level of Development Specification
- LOD and design phase
- LOD and model definition
- LOD scheme

Intentions in the Czech Republic

- Organization in the Czech Republic dealing with BIM issues
- BIM Expert Board - CzBIM - Czech BIM Council
- BIM Management => Building Information Management

8.1. Terms „Level of...

- Level of **Development**
- Level of **Accuracy**
- Level of **Information**
- Level of **Information Detail**
- Level of **Model Definition**
- Level of **Model Detail**

8.2. Level of Development - LOD

- level of documentation processing
    - = amount of informations
- **RFI (information request)**
- Level of Detail
    - informs you about how much detailed information is included in the element model
    - degree to which the geometry of the element and its information are studied

- degree to what extent members of the project team can rely on information when using the model
- LOD Specification
- LODetail = Element input
- LODevelopment = Reliable element output

- Level of Information = LOI

- LODev. = LODet. + LOI

  - = aggregate indicator
  - both LODev and LODet = the amount of information we can get or store in the model.

- Level of Detail

  - with geometric data
  - the term originally came from the CotyGML standard
  - only geometric detail
  - defines the types of objects and their geometric detail from the level of the region to the building's room for each level of detail
  - Level of Development (or project development level)
  - other non-graphical data
  - E202TM 2008 (AIA)
  - for the purpose of designing contractual relationships related to information modeling of buildings
  - described both in terms of details of geometry and in terms of detail, accuracy and range of information on individual objects

BIM Maturity Level

- = the level of documentation, modeling and information transmission in the construction process can be graphically depicted
- created and published in 2008 by Mervynen Richards and Mark Bew

Use of Level of Development

- BIM as a communication tool

  - in the common environment of the model there is both the designer of the building and the other participants in the building process
  - depending on the information in the model given, they can move forward their own work

- Work plan
    - users of the BIM model let them know when the information will be available and at what level of development available
    - this facilitates the LOD framework

- LOD frame
    - provides an industry-standardized standard that describes the development phase of different systems, assemblies and components within the BIM
    - allows consistency in communication and implementation to facilitate the detailed definition of partial goals and outputs in BIM

9. BIM – LOD, SPECIFICATION

9.1. Level of Development Specification

Level of development specifications (LOD Specification)

- is a reference that allows practitioners in the AEC industry to specify and formulate in a high degree of clarity the content and credibility of BIMs at different stages of the design and construction process
- is a detailed explanation of the LOD scheme
- developed AIA
    - adheres to the intention of the LIA Schedule drawn up by the AIA
- defines the characteristics of the model elements of different building systems at different levels of development
- **Intent:**
    - help explain the LOD framework
    - standardize its use so that it becomes much more useful as a communication tool

9.2. LOD

- LOD was accepted for standardization
- all participants should "speak the same language"
- LOD for use in communication and collaboration

LOD and design phase

- LOD is not set at the early stage of the proposal, but rather the finishing phase of the design
- any other landmark or exit may be defined in the LOD language
- reasons for this approach:
    - there is no detailed standard for project phases
    - different standards within one company
    - the progress of building systems from concept to exact definition evolves at different rates
    - there will be different elements at different points at this point in time.
    - after completing the schematic design phase, the model will include many elements at LOD 200, LOD 100, LOD 300, even LOD 400

9.3. LOD and model definitions

Project models

- will always include elements and assemblies at different levels of development

Drawings of objects and their parts are plotted on a certain scale, which also corresponds to the picture detail.

The level of development issues

- lies on the boundary between BIM in terms of Building Information Modeling and BIM in the sense of Building Information Management
- BIM enables the development of effective project management
    - not only in the developmental levels associated with the construction project itself, but also in the subsequent sustainability and management of buildings

LOD values are used for mutual communication.

9.4. LOD scheme

- defines the level of element development
    - at what stage of the life cycle the element is located and what it is
    - determines the reliability of the entered information
- Communication tool + Co-operation tool
- individual participants in the building process enter into an already elaborated building design in such an environment

10. INFORMATION AND KNOWLEDGE MANAGEMENT AT BIM

10.1. Information management

In general

- Communication within the BIM

Environment 4Project = viewpoint for projects 4Project

- Information management in the environment
- Structure
- Recommendation to create INNER DIRECTIONS OF DESIGN COMPANIES

The BIM thought direction is very closely linked to the management of such modeling. Among other things, BIM aims to make cooperation between all participants in the construction process as effective as possible.

10.2. BIM communications

A good combination of different technology tools is required for team collaboration on projects or programs in intelligent environments

- assuming the sharing of knowledge and a common shared structure leading to cooperation

Knowledge visualization

- important for working with knowledge
- represents a presentation of knowledge
- helps professionals to better focus
- navigates in knowledge bases.
- technique facilitating understanding of shared expertise and experience
- understand the action

Example of communication tool

- **Environment 4Project = Viewpoint For Projects**
- collaboration with more than 2000 project teams

This tool is used for:

  - the management itself
  - cooperation,
  - communication
  - project control
  - optimizing business processes

- 4Projects is used not only in construction but also in:

  - energy,
  - mining industry,
  - state administration or education.

- 4Projects received several major awards:

  - Collaboration Construction Computing Awards,
  - Ernst and Young Entrepreneur

- A technology tool for:

  - communication
  - vizualize information
  - exchange of information
  - project proposal management
  - clear data storage

- BIM Management = effective collaboration of all process participants

- The 4Projects environment allows these participants to work on a single model, which is passed on and completed in the form of revisions, thus providing the model with additional information from different professions.

- All communication and planning of the procedure can be carried out through it.

10.3. Structure 4Project = Viewpoint For Projects

Structure allows:

- capture of the individual phases of the project
- saving your own auxiliary versions
- original documentation, etc.

The directory structure of working with data in the 4Projects environment is usually governed by the internal directive of the firm

- This directive describes the individual components of the structure to be stored and how they should be handled.
- respecting the organizational structure of effective project management
- It is possible to send notification of change in the environment via e-mail.

Proposal of interior design directives

- they result from the Building Information Modeling Plan
- so-called BIM Project Execution Plan
    - identification of individual participants in the construction process
    - targeting
    - identification of data area, their details, structure and technical aspects
- Tables
    - identify a particular supplier of a specific part including delivery dates and revisions
    - responsibility for that part of the project proposal
    - live edited

11. KEY TOPICS RELATED TO BIM

Requirements for the properties of building products and building elements for the building information model

- standardization = it is necessary to ensure the quality of the data transmitted
- Standards of information transmission should be set and clearly defined requirements for the properties of construction products for the creation of the information model of the construction.
- Software interoperability must be ensured on the basis of neutral and stable open data formats (IFCs).

11.1. Content of the BIM documentation

- Building law does not have to explicitly mention the existence of the BIM method, it should only create prerequisites for the possibility of electronic submission of documentation.

- Due to the rapid development of information technology, it is better to address specific technical requirements in a different form – e.g. through technical standards or methodologies issued by recognized professional and interest organizations.

- Due to the gradual implementation of the BIM method, it will be appropriate to initially leave the current 2D standard class as it is used and define the BIM documentation as another possible option.

BIM in relation to the budgets, costs and schedule of the construction

- = valuation area (referred to as BIM 5D) - will be significantly affected
- Current valuation and customary practices do not correspond to BIM requirements - their change will be a lengthy and very demanding process
- The whole process should be evolutionary, but with the appropriate dynamics, so that gradual changes can be verified in practice and the corrections are quickly incorporated into the new valuation methodology.
- One of the views can be to determine only the basic binding descriptor of the constructions and to leave a detailed specification of the technology to individual price system makers.

11.2. BIM and Facility Management (FM)

Savings in the FM area are one of the main reasons why BIM

Advantages:

- closer management of the construction site
- more efficient maintenance
- effective energy use
- more efficient maintenance work
- better management of the building's life cycle
- more efficient data transfer between the BIM model
- a CAFM system (Computer-aided FM)

Link to Geographic Information Systems (GIS)

- GIS models are more geared to general spatial information, whereas BIM models are narrowly focused on information about building and construction-related processes.

- The main differences between BIM and GIS models are their creation and scale, and the related level of detail:

    - The BIM model is usually designed as a complex model that is as realistic as possible to be used for analysing and planning the implementation of the project.

    - On the contrary, geographic information systems work with inductive models based on existing data from different sources, and then allow analysis on a model based on existing environment data and spatial and semantic relations of objects in this environment. GIS is also typically used for modeling on a smaller scale (larger area) than BIM.

11.3. Standards, technical standards

Technical standards for BIM are created by combining incentives from the building SMART alliance and individual states towards the organization of ISO and further to the organization of CEN.
Ownership and copyright

In connection with the use of the BIM method, the issue of ownership of the model and copyrights is very often discussed, which can be summarized in these areas:

- copyright and ownership of the proposed building model
- copyrights for used libraries and catalogues used in SW for creating a BIM model

Mandatory / voluntary use of BIM

Foreign experience shows that the most appropriate way for the BIM method to be used extensively, especially for the needs of the state, is to lay down the obligation to use it from a given date for newly awarded public service contracts (building documentation) and construction work.

A number of areas addressed in the context of the introduction of BIM abroad (SW tools, standardization) have already developed significantly, so it seems appropriate to introduce a BIM obligation after a five-year preparation period.

11.4. Procurement (public investors)

For smooth and trouble-free use of BIM, however, it is necessary to solve:

- availability of BIM tools
- changes in legislation
- methodological support

- For project activities:
    - definition of the subject of the public contract
    - question of aggregation of performance
    - determination of qualification requirements
    - setting evaluation criteria

- Construction works:
    - definition of the subject
    - determination of qualification requirements
    - determination of evaluation criteria

11.5. Education

- Is one of the key areas for quality, speed and achievement of expected benefits in connection with the implementation of the BIM.

- In general, more than 50% of the successful implementation of any software solution is decided by well-educated education and change management, i.e. working with people.

- Great demands on the general knowledge and skills of people involved in the BIM implementation of the project and their ability to apply these general principles to the individual conditions of an individual project.

    - There will never be a single global SW solution or exactly the same methodology, it is the standard that one worker will have to combine different SW tools for different projects.

- In BIM training programs, it is important to bear in mind that international and European BIM standards, relevant methodology and foreign literature are based on the principles, processes and terminology of project management and system engineering. Both of these areas should be part of BIM training.

- The importance of cooperation between educational institutions and practice can be seen in foreign experiences. Without examples of best practices and good practice of a proven knowledge base, BIM cannot be successfully implemented. The introduction of BIM in practice, therefore, is crucial for BIM training.

12. BIM IMPLEMENTATION AND FURTHER DEVELOPMENT

The BIM methodology is already in place and begins to talk about it more and more.

- It is precisely in the practical application of the methodology that there is no introduction of certain basic rules to make the most of BIM's benefits.
- For completeness, we reiterate the basic benefits of BIM:

    - saving of costs and time calculated over the life cycle of the building Improving communication between participants in the building process
    - improve the quality of the resulting work and its control
    - increase transparency and better access to decision-making information at different stages of the building's life cycle
    - environmental protection through simulation capabilities at the project preparation stage
    - an opportunity to transform the construction industry and improve the performance of the industry

12.1. Barriers to BIM Adoption

- lack of support by senior management
- implementation Costs (Software and Training)
- the extent of cultural change required
- other Competitive Parallel Initiatives
- lack of fault due to the chain of the investment process
- employee resilience and the problem of ICT literacy
- legal uncertainty

12.2. Pilot projects

- Pilot projects are the first key practical activity in implementing the BIM method into reality.

- Knowledge gained through practical implementation will be very valuable to complement the methodology, standards and sample documents before expanding across the board.

- The pilot projects at this early stage of the implementation of the method should be the verification of partial activities in changing the processes and working procedures of individual workers in connection with the processes of other entities involved in the preparation and implementation of the project.

LITERATURE

BEW, M., RICHARDS, M. 2008 *Why is BIM & why is the Government seeking its adoption* (c) Bew-Richards 2008/10.

ČERNÝ, M. 2013 *BIM příručka*, Praha: Odborná rada pro BIM, ISBN 978-80-260-5296-8.

EASTMAN, C.M., TEICHOLZ, P., SACKS, R., LISTON, K. 2011. *BIM Handbook.* Hoboken NJ: Wiley. ISBN 978-0-470-54137-1.

UNDERWOOD, J., ISIKDAG, U. (Eds.) 2010 *Handbook of Research on Building Information Modeling and Construction Informatics: Concepts and Technologies.* New York: Hershey. ISBN 978-1-60566-928-1.