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D3.3 REPORT ON MATERIAL DEVELOPMENT

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Building BIM digital competences

101183239 – BIM4WB – ERASMUS- EDU-2024-CB-VET

Co-funded by the European Union

PROJECT INFO

Project title	Building BIM digital competences
Project acronym	BIM4WB
Project reference number	101183239
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Web address	https://bim4wb-eu.org/
Coordination institution	IES RIBEIRA DO LOURO
Project duration	36 months

The project aims to design and develop a Building Information Modeling (BIM) curriculum and training materials, focusing on innovating teaching and learning through learner-centered and real problem-based approaches. It includes the training of teaching staff to acquire new practical skills and the establishment of the BIM4WB platform, a user-friendly online resource for sharing knowledge, resources, and best practices related to BIM. The project targets enrolling at least 40 students/professionals in the training course and involves at least 15 teaching staff in personal and professional development skills training. It seeks to align academic offerings with the labor market to enhance student employability, with curriculum content reviewed by stakeholders to ensure it meets industry standards. Bim4WB is co-funded by the Erasmus+ Programme of the European Union during the period January 2025 – December 2027

PROJECT PARTNERS:

1. **IES RIBEIRA DO LOURO**
2. **BALIKESIR UNIVERSITY**
3. **EUROPEAN UNIVERSITY OF TIRANA**
4. **QENDRA PROTIK**
5. **UNIVERSUM INTERNATIONAL COLLEGE**
6. **AGENCY FOR VOCATIONAL EDUCATION AND TRAINING AND ADULT EDUCATION**

Co-funded by the European Union

DOCUMENT CONTROL SHEET

Work package	WP3
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Author(s)	IES Ribeira do louro, Balikesir University
Document status	Final Version
Document version and date	V2 – 14.07.2026

DELIVERABLE EXECUTIVE SUMMARY

This deliverable presents the electronic report of the developed learning materials produced for the BIM4WB programme. The materials had been built collaboratively by Balikesir University and IES Ribeira do Louro, based on the structure proposed in the previous deliverable, D3.2 *Curriculum Structuring*. Partners sought to transform the defined curriculum into a comprehensive set of educational resources that support the effective implementation of the courses.

The main objective of this deliverable is to present the developed materials which integrate theoretical knowledge, audiovisual practical content, self-assessment checklists, quizzes and supporting resources, providing trainers and learners with a complete and implementable educational package. The learning materials presented in this deliverable constitute a key project output, providing the educational resources required for a successful implementation of the BIM courses in the Western Balkan countries. However, previously to its implementation, these learning resources will pass a process of testing implementation for ensuring that they meet the quality requirements, as well as ensure that are totally adapted to the particular needs in this area of Western Balkan countries.

Throughout the development process, partners from Balikesir University and IES Ribeira do Louro worked collaboratively to ensure that the materials reflect the project's objectives while maintaining a harmonized structure across all modules.

VERSIONING AND CONTRIBUTION HISTORY

Version	Date	Revision description	Revision description
V1	10.07.2026	Draft	
V2	14.07.2026	Final Version	

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EXECUTIVE SUMMARY

D3.3 *Report on Material Development* presents the teaching and learning materials developed under the BIM4WB programme, based on the curriculum defined in D3.2 *Report on Curriculum Structuring* and according to the stablished quality requirements and what was agreed within the consortium.

D3.2 established the structure and learning outcomes of the courses on BIM that will be tested and later implemented in Western Balkan countries. This structure was validated through partner consultations and shared with key stakeholders, which ensures the relevance of the content for its future implementation in VET institutions in Albania and Kosovo.

These resources are organised into 5 modules, subdivided in 21 learning units, and present the content progressively. The development of these resources was divided between the Balikesir University and IES Ribeira do Louro. The responsible organization of each module was in charge of producing all the content, that included theoretical content, practical exercises, instructional videos, quizzes, self-assessment activities, and supporting resources designed to facilitate classroom delivery and the implementation. Particular emphasis was placed on producing practice-oriented learning resources to support the development of applied BIM competencies at VET level.

All materials were produced following the common guidelines agreed by the consortium, including the use of shared templates, a common project model, and the use of the same program (Revit 2026), to ensure consistency across modules and facilitate progressive learning. Furthermore, partners worked collaboratively in the development process, maintaining close communication.

Overall, D3.3 transforms the curriculum framework established in D3.2 into a complete, standardized, and implementation-ready set of learning resources, required for the implementation of the courses of BIM.

INTRODUCTION

This report compiles the BIM learning and teaching materials developed in the framework of the project for their testing in the Western Balkan partner organizations, based on the curriculum structure defined in D3.2 *Curriculum Structuring.*

These learning resources divided in 5 modules and comprising 21 learning units, was organized as a progressive learning pathway from introductory BIM concepts to integrated BIM applications and a final project-based case study. The modules were divided among Balikesir University and IES Ribeira do Louro according to the number of hours of training, to ensure that both partners had similar workload. IES Ribeira do Louro was in charge of Modules 1, 2 and 4. Balikesir University was in charge of the Modules 3 and 5.

The development process followed the common guidelines set previously. All partner worked with the same program, Revit 2026. Besides, to ensure the consistency on the materials, all partners worked with the same model, provided by Balikesir University, that allow students to build their knowledge progressively as the content progress.

The materials produced under D3.3 include theoretical content, practical exercises, instructional videos, quizzes, self-assessment activities, and supporting materials aligned with the learning outcomes defined in D3.2.

Throughout the development process, all project partners closely collaborated with partners in charge of its production, giving feedback to the educational resources being developed, mainly based on their technical accuracy, pedagogical coherence, and alignment with both the curriculum objectives and current BIM industry practices.

Accordingly, D3.3 *Material Development Report* presents the complete educational package developed for the BIM4WB programme, documenting the methodology adopted for material production and providing the standardized learning resources that will be used for implementing these courses in Western Balkan training organizations. In the next step of the project, these resources will be tested during a pilot implementation.

Co-funded by the European Union

Module 1

1. Introduction to BIM & Digital construction

This is an application and curriculum guide for a 6-hour interdisciplinary BIM (Building Information Modelling) training designed to provides a structured introduction to BIM as a fundamental methodology within the construction sector.

It addresses its core concepts, historical development, associated challenges, and emerging potential, together with its multidimensional framework ranging from 3D to nD.

The unit further examines the contribution of BIM to improved efficiency, enhanced interdisciplinary collaboration, and compliance with regulatory requirements, with reference to international standards such as ISO 19650 and relevant European and national guidelines. In addition, it offers an overview of widely adopted BIM software solutions and interoperable standards.

Finally, the BIM Execution Plan (BEP) is introduced as a key organizational instrument, outlining project objectives, roles, communication procedures, and information management requirements throughout the project lifecycle.

1.1 Objectives

Understanding BIM Fundamentals: introduce the basic concepts, historical development, principles and multi-dimensional structure (2D, 3D, 4D, 5D..nD) of the Building Information Modeling (BIM) methodology.

Applying BIM in Construction and Procurement: help learners comprehend the possibilities of BIM applications in the construction sector and public procurement.

Selecting BIM Tools Across the Lifecycle: provide the ability to recognize widely used software in the sector and to select software solutions suitable for different stages of the BIM life cycle.

1.2 Learning Methodology

The learning methodology combines teacher-led instruction with active student participation. The teacher will introduce the content through explanations supported by practical examples and audiovisual materials.

Subsequently, students will review the learning resources and analyse the proposed examples to reinforce their understanding. To assess learning outcomes, each student will produce brief summaries and respond to guided questions that demonstrate their comprehension and application of the concepts covered

Learning Outcomes:

1. Explains what BIM is, including its history, evolution, challenges, and potential.

2. Understands and describes the principles and multi-dimensional structure of BIM (3D, 4D, 5D, 6D, 7D, …nD).

3. Evaluates the benefits that BIM provides to the construction sector.

4. Understands the role of international (ISO 19650), European, and national BIM guidelines in ensuring legal compliance.

5. Recognizes widely used BIM-compatible software (e.g., Revit, ArchiCAD, Navisworks, BIM 360, Autodesk Docs) and open BIM standards.

6. Compares the general functions of different BIM tools in relation to stages of the project life cycle.

7. Explains the purpose and importance of a BIM Execution Plan (BEP) in project workflows.

8. Identifies the key components of a BIM Execution Plan, including project information, timeline, BIM roles, and responsibilities.

9. Understands BIM goals, uses, and organizational staffing requirements within a BEP.

10. Describes the principles of BIM exchange protocols, submittal formats, collaboration procedures, and model content requirements.

1.3 Training Duration

The application described in this guide will be carried out through self-regulated learning via the BIM4WB platform.

This training is a total of 6 lecture hours.

1.4 Required Teaching Resources

Hardware requirements: computer lab equipped with computers with access to multimedia and the internet.

1.5 Course Content

All the videos and supporting documents mentioned can be found in the following link: https://drive.google.com/drive/folders/151po7JymM5N6Q70CjQGUB_2fizIdBpvE?usp=sharing

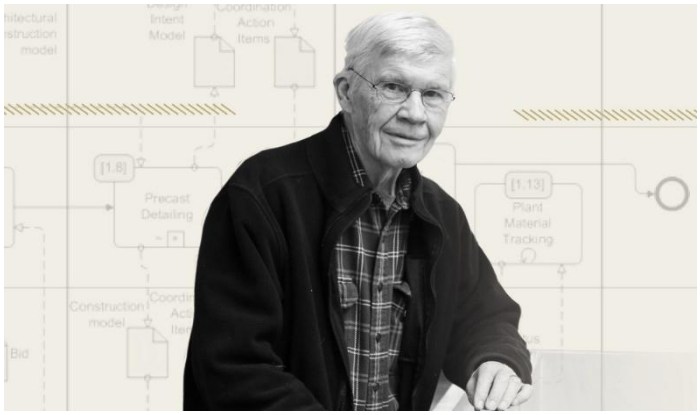
1.5.1 Unit 1

1.5.1.1 What is BIM? BIM concept: history and evolution of BIM. Challenges and potential.

BIM is the acronym used to define “Building Information Modeling” although it could also be understood as Building Information Management, as it is closely related to information management and not only to modeling. But, what does BIM mean?

Many people still think of BIM as a type of software, and it is common to hear it associated with tools such as Revit, Archicad, or other platforms available on the market. However, it is important to clarify that BIM is not a software, even though software is an essential part of it. BIM is a working methodology defined within a collaborative and integrated practice framework, and it represents a profound transformation that affects all design, construction, and asset management processes as traditionally understood.

There are several definitions in the bibliography that can help us understand the concept of this digital tool that is used to manage project data and information of buildings. Among them, one of the best definitions was proposed by Eastman et al. (2011) in the Encyclopaedia of Sustainable Technologies (2017), which defines BIM as:



“A collaborative way for multidisciplinary information storing, sharing, exchanging, and managing throughout the entire building project lifecycle including planning, design, construction, operation, maintenance, and demolition phase”.

Ilustración 1 Charles Eastman (1940-2020), one of the founders of design cognition research (image credit: Georgia Tech) https://iprofessdesign.wordpress.com/2021/05/16/one-concept-per-second-charles-eastman-and-the-beginning-of-design-cognition/

Discover more about Chuck Eastman’s groundbreaking contributions to BIM and digital design through the following tribute: https://dbl.gatech.edu/chuck-eastman-tribute

The concept of Building Information Modeling (BIM) has its origins in the development of digital modeling technologies during the 1960s. In 1963, Ivan Sutherland developed Sketchpad, a system based on wireframe graphics that marked the starting point of digital modeling, introducing the possibility of creating and modifying digital representations of geometry. However, these initial models were limited to graphical information and did not include data about the elements they represented.

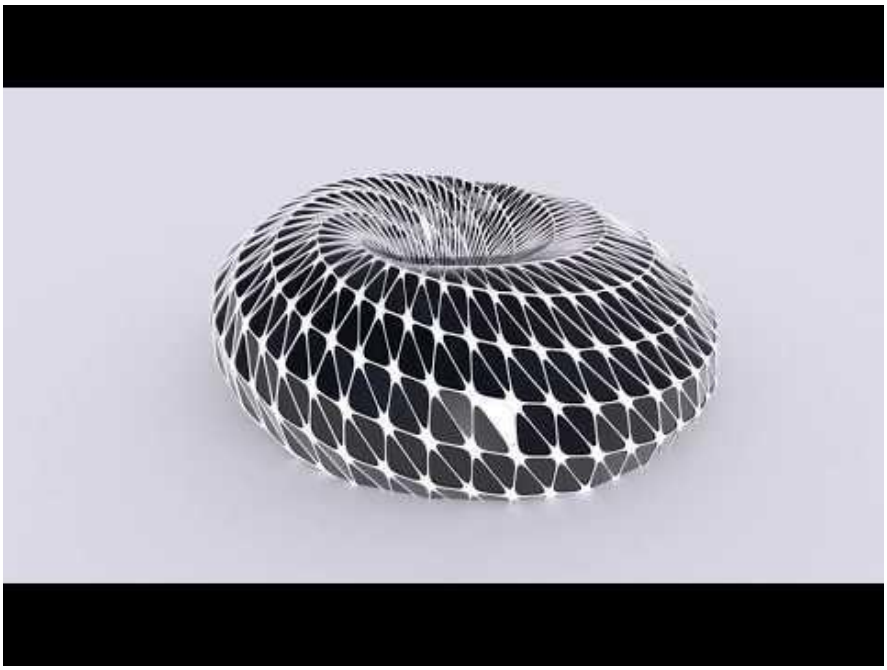
Later, in 1967, Steven Anson Coons introduced surface modeling in an MIT technical report titled “Surfaces for Computer-Aided Design of Space Forms.” Over time, advances in computing allowed the incorporation of information into models, leading to the emergence of building modeling concepts.

The concept of BIM started to take shape in 1974 with Charles Eastman’s publication “An Outline of the Building Description System” (Research Report No. 50). This idea evolved significantly with the introduction of parametric modeling in the 1990s, which marked a turning point, as it enabled the modification of entire models through defined parameters and relationships between elements. It made possible to modify entire models by changing parameters, instead of editing elements individually.

More recently, with further advances technologies, such as reality capture, have improved the accuracy and usefulness of digital data. As a result, BIM has evolved into a comprehensive methodology that integrates geometry, information, and collaboration throughout the entire life cycle of a construction project.

Nowadays, BIM is the holistic process of creating and managing information for a built asset. Based on an intelligent model and enabled by a cloud platform, BIM integrates structured, multi-disciplinary data to produce a digital representation of an asset across its lifecycle, from planning and design to construction and operations.

If you really want to understand what BIM is, the best way is to get involved and actively work on it! The next Autodesk video provides a brief summary of the historical development of BIM. https://youtu.be/gsm15cawHbY



Ilustration 2. Autodesk video what is BIM https://youtu.be/gsm15cawHbY

The development and implementation of Building Information Modeling (BIM) has become a key topic within the digital transformation of the Architecture, Engineering, and Construction (AEC) sector.

As a methodology that integrates digital information, collaborative processes, and intelligent 3D models, BIM introduces both significant opportunities and important challenges for professionals and organizations. On the one hand, it represents a shift from traditional workflows towards more connected and data-driven practices; on the other hand, it requires changes in skills, processes, and organizational culture to be fully effective.

Despite its significant advantages, the implementation of BIM presents several challenges within the AEC industry, these include the high initial investment in software, hardware, and training, as well as the resistance to change from professionals accustomed to traditional design methods.

In addition, the lack of standardized processes and the limited interoperability between different software platforms can hinder effective collaboration among stakeholders. However, BIM also offers substantial potential to improve efficiency, quality, and sustainability throughout the entire lifecycle of construction projects. By enabling integrated digital models, it enhances multidisciplinary coordination, supports informed decision-making, and reduces errors and

costs. Its optimal use involves the implementation of collaborative work environments and structured data management processes, and the adoption of open standards.

BIM is present throughout the entire building lifecycle, as illustrated in the following image

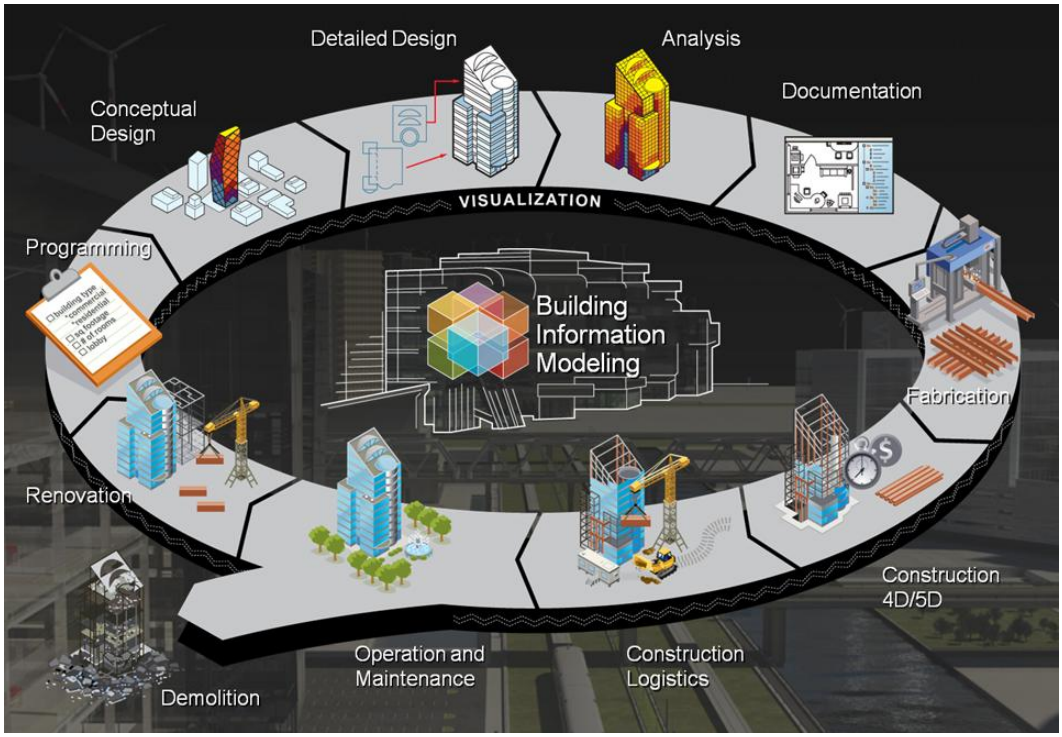


Ilustración 3 . Building Lifecycle. https://www.kaizenai.com/bim/que-es-el-bim/

In the AEC sector, key applications include 3D modeling for visualization, 4D planning for construction scheduling, 5D modeling for cost control, and the integration of facility management data for the operation and maintenance phase.

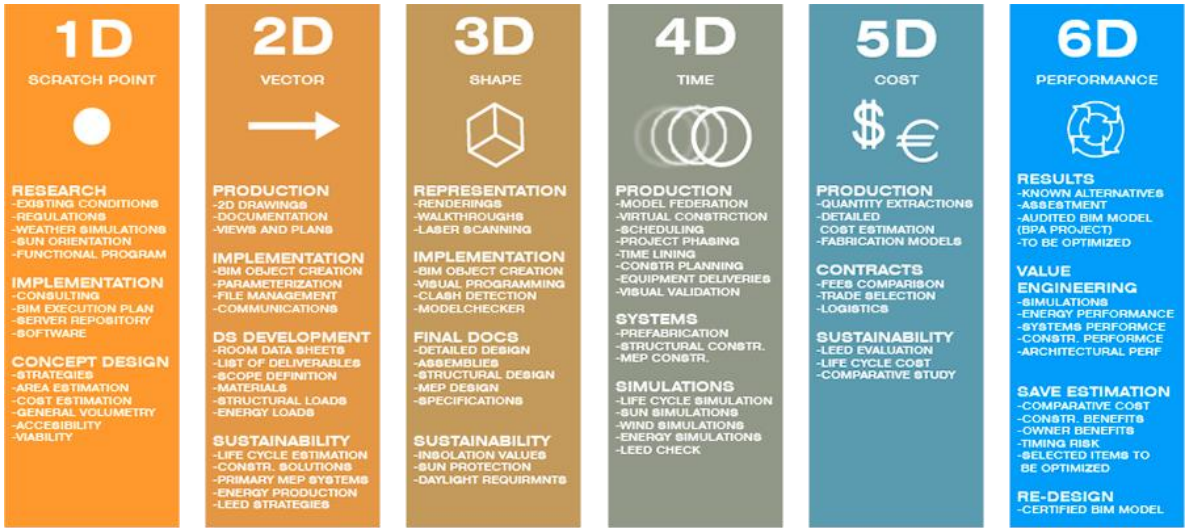
In the AEC sector, key applications include 3D modeling for visualization, 4D planning for construction scheduling, 5D modeling for cost control, and the integration of facility management data for the operation and maintenance phase.

Furthermore, BIM allows the simulation and evaluation of different design alternatives, contributing to more sustainable and optimized construction solutions. As a result, BIM is increasingly recognized as a fundamental methodology for the digital transformation of the construction industry.

1.5.1.2 Principles and dimensions (3D, 4D, 5D, 6D, 7D, …nD.)

Building Information Modeling (BIM) can be understood not only as a 3D modeling methodology, but as a process that integrates different types of information into a single digital model.

To better organize and classify this information, BIM uses a system of "**dimensions**" (nD), where each dimension represents a specific category of data added to the model, such as geometry, time, cost, or sustainability.



Ilustration 4. BIM Dimentions http://www.hildebrandt.cl/wp-content/uploads/2016/05/image003.png?32fc0d

These dimensions can be understood as stages of development in which information is managed, extracted, analyzed, planned, quantified, automated, and optimized throughout the lifecycle of an asset. Below, is a brief explanation of what each of the dimensions means.

1D Refers to the project's initial concept, focusing on basic ideas, requirements, and objectives before any drawings or models are created.

2D Drawings, elevations, and sections with graphics and documentation. Traditional CAD approach. Documentation. Views and plans. PDFs, specifications…

3D Geometric modeling with visual representations of building elements (width, height, depth). 3D models to rendering programs. 3D models across different disciplines to federate models.3D combined with virtual 3D for surveying. Drones, lasers, photometry…

4D Time dimension that links the 3D model with the construction schedule for sequencing simulation or life cycle. Everything related to the timeline. Model federation. Virtual

construction. Scheduling. Project phasing. Time lining. Construction planning. Equipment deliveries. Visual validation.

5D Cost dimension that adds quantity takeoffs and cost estimates to model elements. Quantity extractions. Detailed cost estimation. Fabrication models.

6D Sustainability analysis including energy performance, life cycle assessment, and environmental impact. Know alternatives. Assessment. Audited BIM model. Certification CO2.

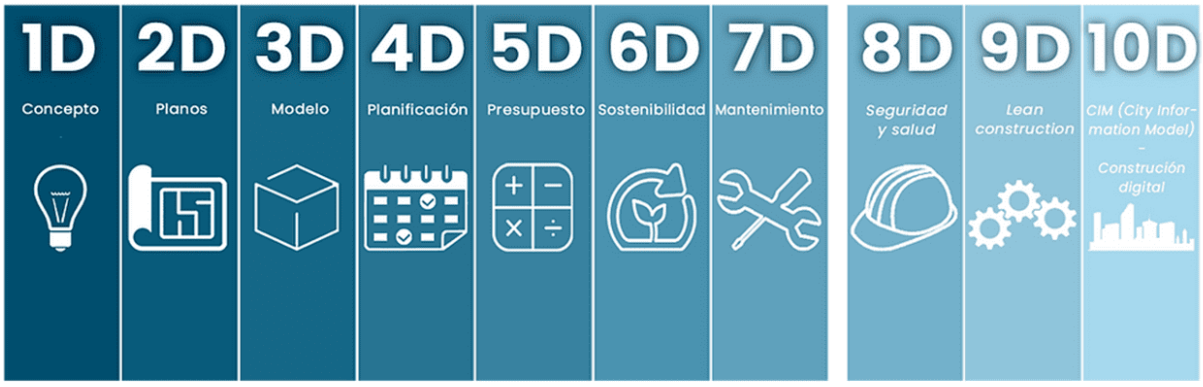
BIM technology is constantly evolving, leading to the continuous expansion of its dimensions. While the most common ones are widely used, newer dimensions introduce more specialized information. In this context, 7D to 10D focus on areas such as facility management, safety, lean construction, and industrialized building methods, although they are still not widely adopted.

7D Facility management data for operations, maintenance schedules programs, and asset management.

8D Safety planning with hazard identification and construction safety simulations.

9D Lean construction principles for waste reduction and process optimization.

10D Industrialized construction and prefabrication data for off-site manufacturing. Examples: 30-story hotel completed in 15 days (T30 Hotel Tower, China) or 15-story building assembled by robots in 12 days (Abu Dhabi).



Ilustration 5. BIM Dimentions 1D-10D https://www.kin.energy/blogs/post/aplicaci%C3%B3n-de-la-metodolog%C3%ADa-bim-cuantificaciones-y-presupuestos

Conceptual extensions beyond standard BIM dimensions include **11D**, linked to artificial intelligence and machine learning for predictive optimization, and **12D**, associated with immersive environments such as augmented and virtual reality (the so-called BIM metaverse), although these lack widespread practical adoption.

In practice, dimensions **3D** to **7D** account for approximately 95% of real-world applications in European projects, whereas **8D** to **10D** are still emerging and remain less widely implemented.

1.5.2 Unit 2

1.5.2.1 Benefits for construction sector

Nowadays, Building Information Modeling (BIM) is a well-established reality that enhances construction processes through a collaborative, data driven approach, going far beyond traditional Computer Aided Design, CAD systems to improve efficiency, coordination, and decision making across projects.

While CAD focuses mainly on geometric drawings, BIM integrates both geometry and information (such as time, cost, and performance) into a single digital model, allowing all stakeholders to work with consistent and updated data.



Ilustration 6. How Components Relate: CAD vs BIM. https://medium.com/specter-automation-insights/introduction-to-bim-making-sense-of-the-buzzword-b73d556a9e01

The use of BIM offers many benefits; however, the most significant ones are described below.

First, BIM enhances **collaboration and coordination**, as teams work in a shared environment that reduces communication errors and improves decision-making.

Second, it increases **efficiency and productivity** by enabling better planning, simulation, and workflow organization, which helps deliver projects faster.

Third, BIM supports **cost control**, since it reduces design errors and rework while linking design with budgeting processes. It also improves **risk management and safety**, as potential conflicts can be detected early and managed before construction begins.

Finally, BIM contributes to better **lifecycle management**, allowing information created during design and construction to be used later in operation and maintenance, which is not possible with traditional CAD workflows.

The following video introduces the BIM–BAM–BOOM concept, illustrating how digital methodologies can generate significant cost savings depending on the stage of a project.

It emphasizes that the earlier BIM is implemented—particularly during the design phase (BIM)—the greater the potential savings, as changes can be made quickly and at low cost. As the project progresses into construction (BAM), modifications become more expensive and require greater effort. Finally, during the operation and maintenance phase (BOOM), changes are the most costly and complex to implement. This highlights the importance of early decision making and the value of BIM in minimizing errors, optimizing resources, and improving overall project efficiency.

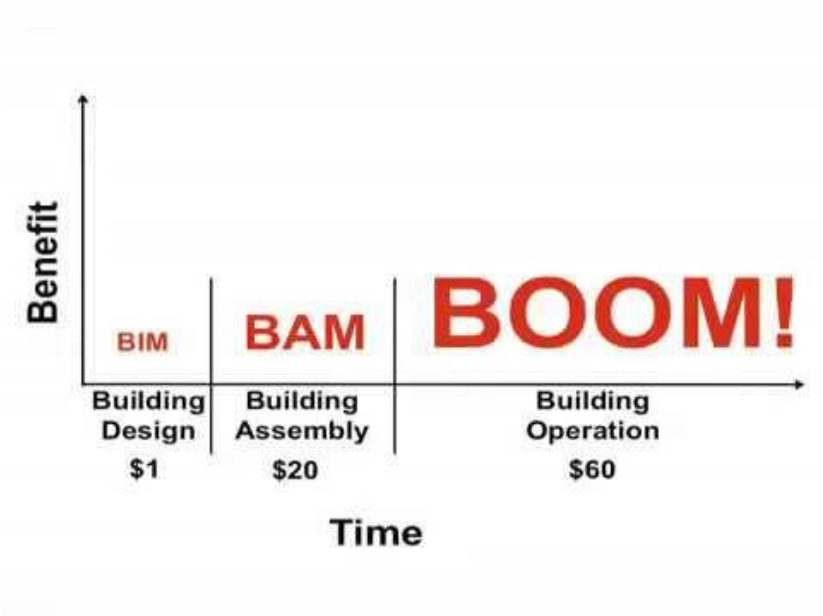


Ilustración 7. BIM, BAM, BOOM. https://www.youtube.com/watch?v=zpPqtklzpbk

1.5.2.2 ISO 19650, EU and national BIM guidelines (Albania/Kosovo), Legal compliance.

ISO 19650 titled "Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)". is an international standard that establishes the principles and requirements for the management of information over the whole life cycle of built assets using Building Information Modelling (BIM).

Its development is directly rooted in the United Kingdom's earlier standards, particularly BS 1192 and the PAS 1192 series, which were created following the UK Government's BIM strategy launched in 2011 to improve efficiency, collaboration, and cost predictability in public construction projects.

As these UK standards gained international acceptance, stakeholders from multiple countries called for a globally applicable framework, leading the International Organization for Standardization **(ISO)** to adopt and expand them into the ISO 19650 series.

The first parts, **ISO 19650-1 and ISO 19650-2**, were published in 2018, defining fundamental concepts, principles, and information management processes during the delivery phase of assets, these, were later expanded with **ISO 19650-3 (2020)**, which addresses the operational phase of assets, and ISO **19650-5 (2020)**, which introduces a security-minded approach to information management. The series continued evolving with **ISO 19650-4 (2022)**, focusing

on information exchange processes and quality control, and most recently **ISO 19650-6 (2025)**, which integrates health and safety information into BIM workflows

ISO 19650 represents the consolidation of decades of BIM evolution, transforming early digital modeling concepts into a fully standardized global methodology for information management in construction. It establishes a structured and collaborative approach to managing information across the entire lifecycle of built assets, based on key elements such as common data environments, clearly defined roles, and standardized processes for information production and exchange.

Its progressive development reflects the increasing maturity of BIM, evolving from basic principles and project delivery practices into a comprehensive, lifecycle-oriented and specialized framework that supports collaboration, standardization, interoperability, and data reliability at an international level.

This table provides a summary of the evolution of the standards.

Standard	Main Focus	Year
ISO 19650-1	Concepts and principles. General concepts and principles of information management with BIM (terms, roles, CDE, lifecycle).	2018
ISO 19650-2	Design and construction (delivery phase). Information management processes in the asset delivery phase (project/construction).	2018
ISO 19650-3	Operation and maintenance (asset lifecycle). Information management processes in the asset operation phase (operation and maintenance).	2020
ISO 19650-5	Information security. Information management processes in the asset operation phase (operation and maintenance).	2020
ISO 19650-4	Information exchange and validation. Rules and best practices for information exchange (what is delivered, in what format, and with what quality).	2022
ISO 19650-6	Health and safety information (latest)	2025

As can be seen, ISO 19650 is continuously evolving and currently consists of six parts. In this context, the focus will be placed mainly on the first two parts. However, it is important to note

that on March 25, 2026, a draft revision of these parts was published for public consultation. Although it is not yet the final version, this document provides a clear indication of the direction of future changes.

Albania and Kosovo are currently in an early and non-regulated stage of BIM implementation, with no verified national BIM mandates or formal legal frameworks aligned with ISO 19650. The construction sector in both countries still operates largely under traditional CAD-based workflows, and the adoption of BIM is mainly voluntary and project-specific, particularly within private companies or more advanced projects

The need to introduce BIM in both countries has emerged primarily as part of a broader digital transformation process, driven by alignment with European Union policies and digital agendas.

In **Albania**, this is reflected in national strategies such as the Digital Agenda 2022–2026, which promotes the integration of digital technologies across sectors to improve efficiency, transparency, and competitiveness. Similarly, **Kosovo** has adopted a Digital Agenda 2030, aligned with EU frameworks, aiming to modernise public services, businesses, and infrastructure through digitalisation. Within this context, BIM is understood as part of the broader shift toward data driven construction processes, even if it is not yet embedded in legislation.

From a sector perspective, BIM adoption has been motivated by practical needs rather than regulation, including:

- Improving coordination and project management
- Increasing productivity and efficiency
- Responding to growing project complexity and international collaboration requirements

Academic and regional analyses confirm that the construction sector across the Western Balkans is undergoing a progressive digital transition, but still faces barriers such as lack of standards, limited training, the additional cost of software and low institutional enforcement still represent barriers to the full adoption of BIM.

Evidence from local training and professional environments in Kosovo shows that Archicad and ISO 19650-based workflows are already being introduced in professional training contexts, indicating a gradual transition toward international BIM practices

Regarding tools, the BIM ecosystem in Albania and Kosovo follows the general trend observed across the Balkans:

Autodesk Revit is the most widely adopted BIM software in larger or multidisciplinary projects due to:

- better coordination capabilities
- compatibility with international workflows
- alignment with industry standards and complex project requirements

Graphisoft Archicad is also used, especially in:

- smaller architectural studios
- design-oriented practices
- environments prioritising flexibility and ease of use

In summary, Albania and Kosovo are in a transitional phase: BIM is present but not regulated, ISO 19650 is known but not mandatory, and adoption is driven by digitalisation strategies, private sector demand, and alignment with EU standards rather than national legislation.

The market is gradually shifting from CAD to BIM, with Revit and Archicad as the main tools, but the absence of a formal regulatory framework means that implementation remains fragmented and uneven, depending on project scale and stakeholder capacity.

1.5.3 Unit 3

1.5.3.1 Introduction (Building Information Modeling compatible programs: Revit, ArchiCAD, Navisworks, BIM 360, Autodesk Docs, and open BIM standards).

As is widely recognized, BIM is a collaborative methodology that integrates digital technologies to create, manage, and exchange structured information throughout the lifecycle of built assets.

It is supported by a diverse ecosystem of software tools and standards, each fulfilling a specific role within the digital workflow of architecture, engineering, and construction (AEC). Its effectiveness relies on a robust ecosystem of software tools that support modeling, coordination, data management, and interoperability.

There are a widely used BIM software tools across different stages of the project lifecycle.

- **Modeling software**: Revit, Archicad, Edificius, Allplan, AecoSim, Digital Project, Construsoft, Data Design System…
- **Data Management software**: Navisworks, Solibri, Teckla…
- **Planning/Simulation software**: Synchro Pro, Vico Office…
- **Quantity and Cost Control software**: Arktec, Cost It, Arquimedes, TCQ, Mamba
- **Material Factor Management (MFM) software**: YouBIM, Archibus, FMSystems…

- **Viewers**: Bimx, Teckla, Solibri, Design Review, Data View…

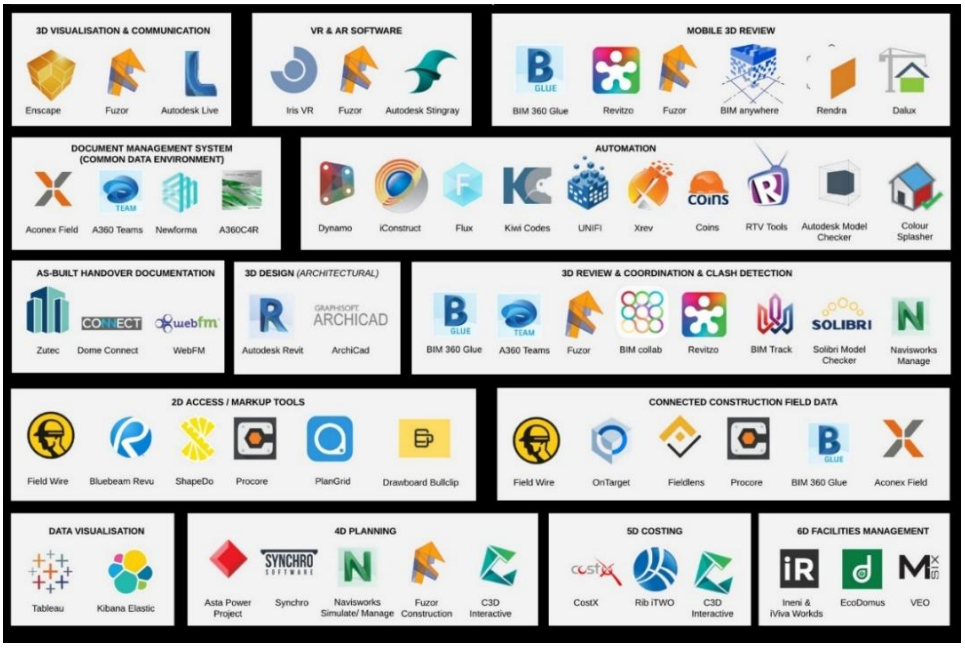


Ilustración 8. The most widely used BIM software tools across different stages of the project lifecycle https://www.linkedin.com/pulse/digital-collaboration-tools-which-one-use-daniel-kalnins

Among the most widely used BIM-compatible programs are **Autodesk Revit**, **Graphisoft Archicad**, **Autodesk Navisworks**, **BIM 360**, **Autodesk Docs**, and **open BIM standards,** all of which play complementary roles in a BIM workflow.

Autodesk Revit is one of the most widely adopted BIM authoring tools globally. It provides a comprehensive platform for architectural, structural, and MEP (mechanical, electrical, and plumbing) design within a single parametric environment. Revit enables the creation of intelligent 3D models in which elements are data-rich and interconnected, allowing automatic updates across all views when modifications are made. Its strong integration with other Autodesk tools and its ability to support multidisciplinary collaboration make it a core solution for large-scale BIM projects.

Revit (Autodesk): https://www.autodesk.com/products/revit/overview

Graphisoft Archicad is another leading BIM authoring platform, particularly recognized for its architect-centric approach. It emphasizes ease of use, intuitive design workflows, and strong visualization capabilities. Archicad is closely aligned with the open BIM philosophy, supporting interoperability through standards such as IFC. While it is widely used

in architectural design, especially in Europe, it is also capable of supporting collaborative workflows across disciplines.

ArchiCAD (Graphisoft): https://graphisoft.com/en-us/plans-and-products/archicad/

Autodesk Navisworks is a coordination and review tool rather than a modeling application. Its primary function is to aggregate models from different disciplines into a federated environment, enabling comprehensive project analysis. Key features include clash detection, 4D simulation (linking models to time schedules), and model-based quantity takeoffs. These capabilities allow project teams to identify conflicts and optimize construction planning before execution, reducing errors and costs.

Navisworks (Autodesk): https://www.autodesk.com/products/navisworks/3d-viewers

Autodesk BIM 360 (part of the Autodesk Construction Cloud) is a cloud-based platform designed to enhance collaboration and project management. It enables multidisciplinary teams to work on shared models in real time, manage documentation, track issues, and coordinate workflows across the project lifecycle. By centralizing information in a common data environment (CDE), BIM 360 improves transparency, reduces duplication, and ensures consistent access to project data.

BIM 360 (Autodesk): https://www.autodesk.com/bim-360/

Autodesk Docs complements BIM 360 as a centralized document management solution within the Autodesk ecosystem. It serves as a cloud-based repository for storing, organizing, and sharing project files, ensuring version control and secure access to information. Autodesk Docs supports efficient data governance and facilitates collaboration by maintaining a single source of truth for all stakeholders involved in the project lifecycle.

Autodesk Docs: https://www.autodesk.com/products/autodesk-docs/overview

In addition to proprietary platforms, **open BIM standards** are essential for ensuring interoperability across different software environments. The most important of these is the **Industry Foundation Classes (IFC)** format, developed by **buildingSMART.** IFC is an open, vendor-neutral data model (ISO 16739) that

enables the exchange of structured BIM information—such as geometry, properties, and relationships—between different software applications without loss of data integrity.

BuildingSMART International is a global, non-profit organization that promotes the digital transformation of the construction industry by developing open and interoperable BIM standards

Its main role is **to enable efficient information exchange between different software platforms and stakeholders,** ensuring collaboration throughout the entire project lifecycle

To achieve this, buildingSMART develops and maintains key standards such as:

- IFC (Industry Foundation Classes) for model data exchange
- BCF (BIM Collaboration Format) for issue communication
- IDS (Information Delivery Specification) for defining information requirements

These standards form the basis of the open BIM approach, which promotes vendor-neutral workflows, long-term data accessibility, and interoperability across different tools and disciplines.

openBIM – buildingSMART (estándares IFC, BCF, IDS, etc.): https://www.buildingsmart.org/about/openbim/

Another key standard is **COBie (Construction Operations Building Information Exchange)**, which focuses on the structured delivery of non-geometric data related to assets, such as equipment specifications, warranties, and maintenance information. COBie facilitates the transition from construction to facility management by ensuring that critical operational data is available in a standardized digital format.

Construction Operations Building Information Exchange, COBie https://nibs.org/nbims/v3/cobie/1-2/

Together, these tools and standards form an integrated BIM ecosystem. Authoring tools like Revit and Archicad generate data-rich models, coordination platforms like Navisworks validate and optimize them, cloud environments such as BIM 360 and Autodesk Docs manage and share information, and open standards like IFC and COBie ensure interoperability across all stages of the project lifecycle. This synergy enables more efficient, collaborative, and data-driven processes in the architecture, engineering, and construction (AEC) industry.

1.5.4 Unit 4

1.5.4.1 BIM Execution Plan overview

• What is the BIM Execution Plan

The **BEP (Bim Execution Plan)** is a planning and management document that establishes the rules, processes, roles, tools, and information workflows that must be followed by all stakeholders involved in a BIM project.

Although this document has traditionally been known as the BIM Execution Plan, it should be noted that, in the latest revision of the ISO 19650 standard on March 2, 2026, it has been established that in its next update it will be referred to as the **Information Production Plan or PPI.**

ISO 19650 does not simply change the name of the document. It updates the entire set of terms related to the production and delivery of information in BIM projects. These terminological changes are significant because they reflect a more precise and mature understanding of what it means to manage information in the construction sector.

- BIM Execution Plan → **Information Production Plan**.
- Delivery Team → **Information Production Team**.
- Exchange Information Requirements → **Information Production Requirements**
- Information Delivery Milestones → **Information Production Milestones.**
- Task Information Delivery Plan + Master Information Delivery Plan → **Information Production Programme**.
- Various versions of responsibility matrices → **Information Production Assignment Matrix**.

All these changes point in the same conceptual direction: ISO 19650 no longer limits its scope to the delivery phase of the built asset. Today, the standard covers the entire lifecycle, including operation, maintenance, refurbishment, and end-of-life. This expansion has direct implications for how the Information Production Plan is developed and managed. It reflects a profound conceptual evolution that every BIM professional must understand if they aspire to work at the level demanded by the high-value market.

A complete **Information Production Plan (PPI)** aligned with ISO 19650 must be structured based on the elements that the standard defines as fundamental.

The **Information Production Requirements**: a precise description of what information the contracting party needs at each stage of the project or asset lifecycle, with what level of information need and in what format.

The **Information Production Schedule**: the dates when each information container must be delivered, the people responsible for each delivery, and the acceptance criteria, organized around Information Production Milestones.

The **Information Production Strategy**: which software tools will be used to produce each type of information, how the information models from different Information Production Teams are federated, and what the protocols are for data exchange and export between disciplines.

The **Information Production Assignment Matrix**: who is responsible for producing each information container, who reviews it, who approves it, and who authorizes it within the Common Data Environment.

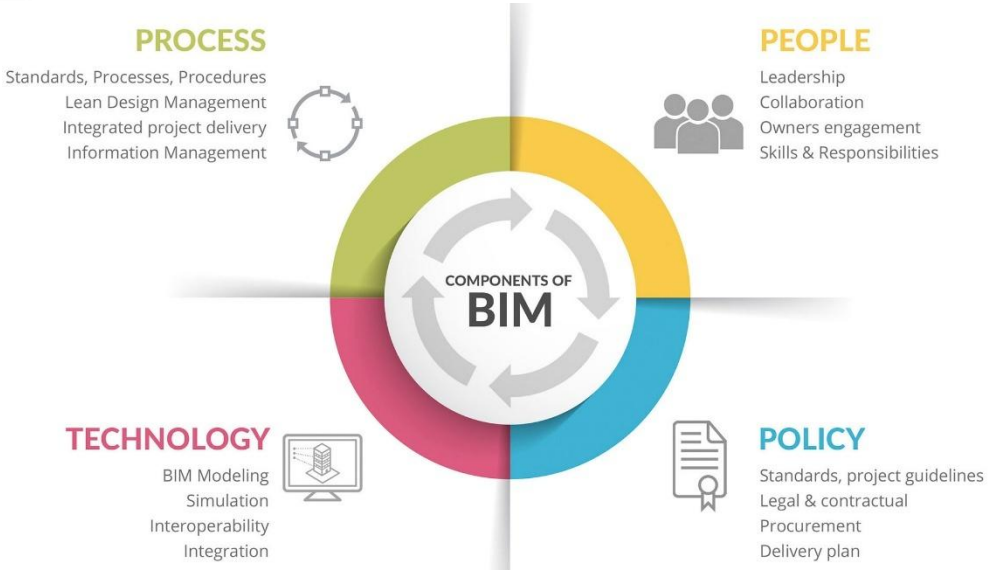
The **Information Production Standards**: file naming conventions, classification systems, folder structures, coordinate systems, and any other agreements that ensure the consistency and interoperability of information throughout the entire project.

The definition of the **Common Data Environment**: the platform or set of platforms where project information is managed and shared, along with its workflow states and security protocols.

Its important remark that **this is not the latest version**. The public consultation on ISO 19650 Parts 1 and 2 draft revisions is open from 10 March 2026. After consultation and amendments, the new version is expected in 2027.

Meanwhile the new version is being approved, we will continue applying the well known BEP.

The main objective of the **BIM Execution Plan** is to define how BIM processes will be implemented, managed, and coordinated throughout the project, while also acting as an operational guide that outlines the project infrastructure, including the technologies to be used, the teams responsible, the contractual requirements, as well as how modelling, data exchange, and team coordination will be carried out across the entire lifecycle of the asset.



Ilustration 9. Components of BIM. https://amusementlogic.es/noticias-de-la-empresa/plan-de-ejecucion-bim-en-proyectos-de-ocio-y-turismo

In this sense, it is considered a key document for the successful implementation of BIM, as it organizes workflows and reduces errors and communication issues.

It should be noted that there is no universal method for applying BIM to all projects. Each team must develop an effective BIM implementation strategy adapted to its specific context. Therefore, only a team that understands the project objectives, characteristics, and the capabilities of its members will be able to apply BIM effectively. Once the plan has been created, the team must monitor progress against it. Continuously developing, updating, and refining the plan at each stage of the project is essential to achieve the maximum benefits from BIM implementation.

• Why is the BIM Execution Plan done

The project team should develop a **BIM Execution Plan (BEP)** in order to effectively integrate BIM into the project delivery process. This plan serves as a guiding document that defines both the overall vision and the implementation details that all participants must follow throughout the project lifecycle.

The BIM Plan is developed in the early stages of the project, continuously evolves as new participants join, and is monitored, updated, and revised throughout the implementation phase. Its main purpose is to establish key aspects such as the scope of BIM implementation, the

workflow processes, the information exchanges between parties, and the infrastructure required to support implementation.

By developing this plan, several key benefits are achieved. First, all parties clearly understand and communicate the strategic goals of BIM implementation within the project. In addition, each organization gains a clear understanding of its roles and responsibilities, improving coordination among team members.

The plan also enables the team to design execution processes that are aligned with each member's business practices and typical organizational workflows, while identifying any additional resources, training, or competencies needed for successful implementation. Furthermore, it serves as a reference for future participants joining the project and helps procurement teams define contractual requirements to ensure that all parties fulfill their obligations.

Moreover, the BIM Plan establishes a baseline that allows progress to be measured throughout the project, acting as a benchmark for evaluation.

Finally, since BIM, like other new technologies, can introduce certain risks—especially when teams lack experience or familiarity with each other's processes—the development of this plan adds significant value by reducing uncertainty. In turn, this minimizes implementation risks and improves the overall efficiency of the project.

• BIM Execution Plan components

The **BIM Execution Plan (BEP)** is composed of a set of fundamental elements that allow BIM implementation in a project to be structured in a clear and organized manner. According to the BIM Project Execution Planning Guide, Version 3.0, from Computer Integrated Construction Program, Penn State (University Park, PA, USA), these components are organized around a five-step procedure that ensures detailed, coherent, and effective planning.

First, the BEP includes the **definition of BIM goals and uses** within the project. This involves identifying what is intended to be achieved through BIM and how it will be applied, thereby establishing a clear strategic foundation for all participants.

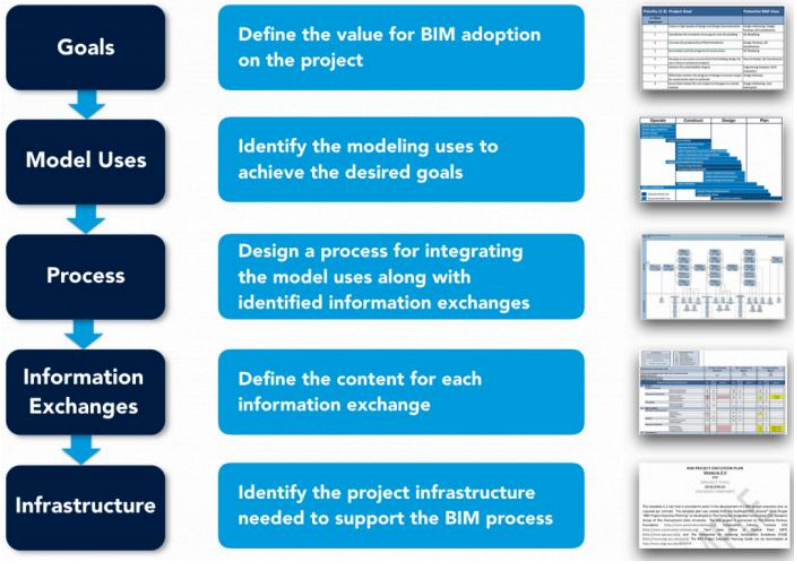
Second, it addresses the **design of the BIM execution process**, where workflows are structured and the way in which BIM-related activities will be carried out throughout the project is defined. This component ensures efficient coordination among all stakeholders.

The third component is the **definition of BIM deliverables**, which involves specifying the information and outputs to be produced during the project. This includes what must be delivered, in which format, and at what stage, facilitating effective information management.

Next, the BEP incorporates the iden**tification of the required supporting infrastructure**, which includes the technical, technological, and organizational resources needed to successfully implement BIM, ensuring that all participants have the appropriate means.

Finally, the plan can be supported by a set of **existing templates and support tools**, which are often freely available and designed to facilitate the implementation of each of these steps. These templates help standardize the process and ensure that plans are consistent and replicable across different projects.

Overall, these components enable the development of a comprehensive and well-structured BEP, validated through prior research processes involving real companies in the sector. This contributes to improving planning, coordination, and BIM implementation in projects.



Ilustration 10. BIM Project Execution Planning Guide. Version 3.0 https://psu.pb.unizin.org/bimprojectexecutionplanning/

Furthermore, by way of example, within the five phases described above, a large-scale project is required to address fourteen specific categories underpinning its infrastructure:

1. verview Information (Reason for the plan).
2. Project Information (Numbers, location, schedule).
3. Key Project Contacts.
4. Project Goals / BIM Objectives.
5. Organizational Roles / Staffing.
6. BIM Process Design (Process maps).
7. BIM Information Exchanges.
8. BIM and Facility Data Requirements.
9. Collaboration Procedures.
10. Quality Control Procedures.
11. Technological Infrastructure Needs.
12. Model Structure (Naming, coordinates).
13. Project Deliverables.
14. Delivery Strategy / Contract.

1.5.4.2 Project information

• BIM Execution Plan timeline

The BIM Execution Plan (BEP) should be developed during the early stages of the project and continuously refined as new participants (subcontractors/consultants) join the project team. Throughout the implementation phase, the plan must be regularly monitored, updated, and revised to ensure it remains aligned with project needs. The BEP is a **living document**.

Its development is carried out through a structured planning process involving a series of collaborative meetings, typically ranging from two to four, supported by intermediate tasks that enable the team to progressively define and consolidate the plan. Standard timeline involves a series of **four collaborative meetings**:

1. **Meeting 1:** Identify BIM Goals and Uses.
2. **Meeting 2:** Design the BIM Execution Process (Mapping).
3. **Meeting 3:** Develop Information Exchanges and Infrastructure.
4. **Meeting 4:** Final Review and adoption of the plan.

• Key project contacts

The BIM Execution Plan (BEP) must include the identification of key project contacts by assigning at least one representative for each stakeholder involved in the project.

These stakeholders typically include the owner, designers, consultants, prime contractors, subcontractors, manufacturers, and suppliers, ensuring that all relevant parties are clearly represented.

Stakeholder	Description
Owner	Project promoter responsible for defining requirements and overall project objectives
Designers	Professionals responsible for developing the design of the project
Consultants	Specialists providing technical advice and expertise in specific areas
Prime contractors	Main contractors responsible for project execution and coordination on site
Subcontractors	Companies or teams carrying out specific parts of the construction work
Manufacturers and suppliers	Entities responsible for providing materials, products, and equipment

These contacts may correspond to various professional roles within the project team, such as Project Managers, BIM Managers, discipline leads, superintendents, and other key personnel responsible for decision-making and coordination.

Furthermore, the contact information must be collected and shared among all participants to facilitate communication and collaboration. When possible, this information should also be made available through a shared collaborative platform, enabling efficient access and coordination throughout the project lifecycle.

• BIM roles and responsibilities

The BIM Execution Plan (BEP) must clearly define organizational roles and responsibilities to ensure effective implementation of BIM throughout the project lifecycle.

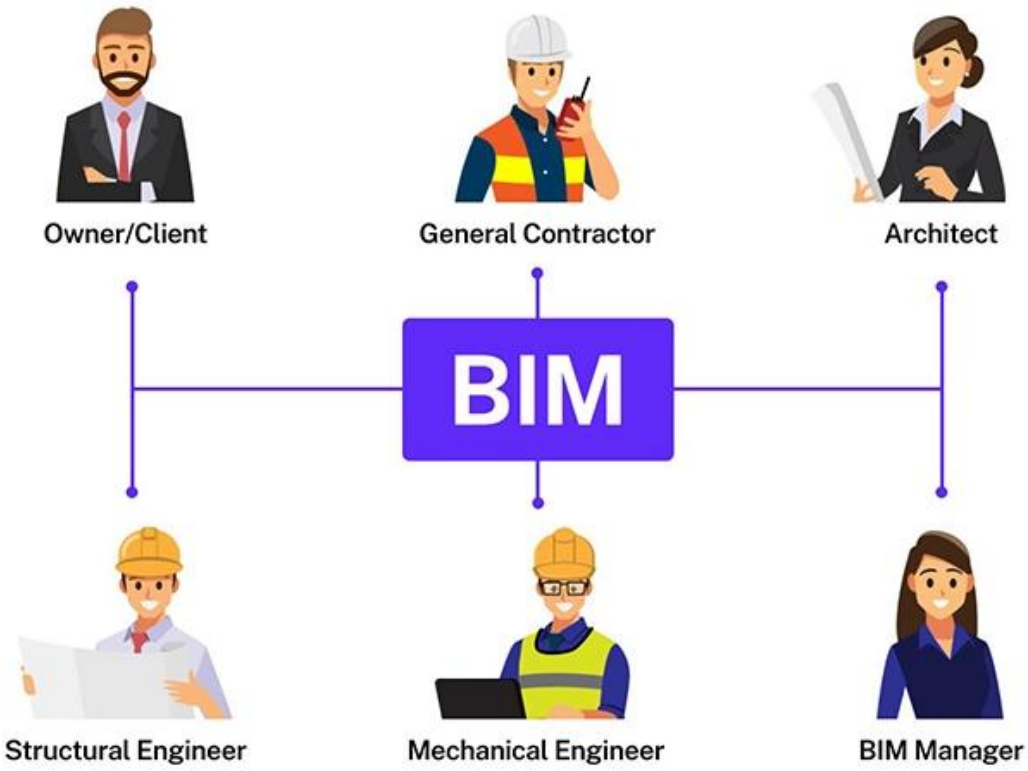


Ilustración 11. BIM roles and responsabilities. https://ddcsolutions.co.uk/bim-roles-and-responsibilities/

This section defines the roles and responsibilities required for BIM implementation, identifying the individuals or organizations responsible for coordinating the BIM process (e.g., BIM Manager or BIM Coordinator) and assigning accountability for each BIM Use. It also establishes which entity leads the development and overall coordination of the BEP.

Responsibility must be clearly allocated for every process and information exchange to ensure proper management and control of tasks and deliverables. These definitions support effective coordination among project participants and should be established at early stages and updated as the project evolves and new stakeholders are incorporated.

Role	Responsibility
BIM Manager	Responsible for overall project efficiency, BIM implementation, resource management, and organization-wide training
BIM Coordinator	Ensures all teams are aligned with project goals, coordinates various disciplines, and resolves technical issues
BIM Modeler	Creates and manages detailed 3D models and design documentation following the BIM Execution Plan (BEP)

BIM Architects & Designers/ Engineer	Translates the project vision into digital designs and collaborates across disciplines for successful delivery
BIM Construction Manager	Uses the model for planning, scheduling, budget analysis, and proactive risk management
BIM Facility Manager	Utilizes accurate model data for the efficient maintenance and operation of the infrastructure

In summary, the success of a BIM project depends on each stakeholder understanding their specific role and collaborating closely with others within the digital framework

• BIM use staffing

The BIM Execution Plan (BEP) must define in detail the staffing requirements for each identified BIM Use in order to ensure an effective and coordinated implementation. For every BIM Use, the plan should specify the organization or organizations responsible for executing the task, clearly assigning accountability within the project team.

In addition, it should identify the number of personnel required, their professional profiles or job roles, the estimated working hours needed to complete the activity, and the primary location where the work will be performed.

Furthermore, a lead contact or responsible person must be designated for each BIM Use to ensure proper coordination and communication.

Beyond defining staffing, the guides consulted emphasizes the importance of evaluating the capabilities of the involved organizations. This includes assessing the availability of resources such as personnel, software, hardware, and support systems, as well as the competencies required to successfully carry out each BIM Use. The team must also consider prior experience with similar uses, as this is a critical factor influencing the success of the implementation.

By combining clear staffing definitions with an evaluation of resources, competencies, and experience, the BEP ensures that each BIM Use is appropriately supported and that the project team is fully prepared to execute the planned activities efficiently.

1.5.4.3 Project BIM Goals and BIM Uses

This section presents the objectives defined within the BIM Project framework and identifies the BIM Uses that support and align with these objectives

• Major BIM Goals / Objectives

To develop an effective BIM Execution Plan, it is essential to consider the benefits that BIM can bring to the project and to establish the objectives to be achieved based on these advantages. In order to define these objectives successfully, they should be relevant to the specific project, as well as measurable and achievable for the project team.

The project team should document BIM objectives for each project phase. Examples are provided below

- **Example Goal:** "Reduce field installation rework by 20% through 3D Design Coordination".
- **Example Goal:** "Achieve LEED Gold certification by using Energy Analysis models to optimize the facade".

• BIM Uses

BIM Uses refer to the specific applications of Building Information Modeling implemented to achieve the defined project objectives. They describe how BIM is applied throughout the project lifecycle, translating goals into concrete actions such as:

- Design review
- 3D coordination
- Cost estimation (5D)
- 4D planning
- Energy analysis
- Facility management

In this sense, BIM Uses act as the link between the project's objectives and their practical implementation, as they determine the processes to be carried out, the information to be generated, and the expected deliverables.

A key aspect is that BIM Uses focus on what is achieved through BIM rather than the tools or methods employed, providing a common framework for defining and communicating how BIM adds value to the project. By establishing this connection, they ensure that each objective is supported by clearly defined tasks, responsibilities, and information exchanges throughout the project

A BIM Use is a unique task on a project that benefits from BIM. To select them, teams should "Begin with the end in mind," looking at what the owner needs for operations and working backward.

• Organizational Roles / Staffing

The Organizational Roles and Staffing section defines the structure, roles, and allocation of human resources required to support BIM implementation within the project. Its primary objective is to ensure that all participants clearly understand their responsibilities, facilitating effective collaboration, coordination, and information management throughout the project lifecycle.

This section identifies the key BIM roles necessary for the project, such as BIM Manager, BIM Coordinator, Information Manager, and Model Authors, and assigns responsibilities to each role in accordance with the defined BIM Uses and project objectives. The definition of roles must be aligned with the scope, complexity, and intended outcomes of BIM implementation, as different BIM Uses introduce specific requirements related to modeling, coordination, and information exchange.

In addition to defining roles, this section specifies the staffing strategy, including the assignment of individuals or organizations to each role, their level of involvement, and the competencies required to perform their functions effectively. A clear allocation of responsibilities is essential to avoid overlaps, gaps, or miscommunication, ensuring that all processes and deliverables are properly managed and controlled.

Furthermore, the organizational structure should reflect both traditional project roles and BIM-specific functions, integrating them into a coherent framework that supports multidisciplinary collaboration. Since BIM roles may be performed by one or multiple individuals depending on project needs and resources, flexibility in role assignment is necessary while maintaining clear accountability.

This section should be established during the early stages of the project and reviewed periodically to reflect changes in team composition, project scope, or BIM requirements, ensuring that the organizational structure remains aligned with the evolving needs of the project.

Once BIM roles and responsibilities have been defined, it is essential to ensure that the assigned organizations or individuals have the appropriate capabilities to perform each BIM Use.

In this context, the team should assess the capability of each participant based on their available resources (software, hardware, and IT support), competency (technical knowledge and skills), and prior experience in similar BIM Uses.

- Resources: Do they have the software, hardware, and IT support?
- Competency: Do they have the "know-how" for that specific task?
- Experience: Have they successfully performed this BIM Use in the past?

This evaluation ensures that responsibilities are not only clearly allocated, but also assigned to suitably qualified parties, thereby supporting the effective implementation of BIM processes and the achievement of project objectives.

1.5.4.4 BIM exchange protocol and submittal format

This section defines the protocols governing electronic communication and the requirements for the exchange, formatting, and delivery of BIM data throughout the project lifecycle. Its primary objective is to ensure that all project information is generated, shared, and managed in a consistent, structured, and interoperable manner, in accordance with established standards such as ISO 19650

• Electronic communications and BIM data requirement format

All communications and data exchanges shall be conducted through a Common Data Environment (CDE), which serves as the central platform for storing, managing, and sharing project information. The use of a CDE ensures that all participants work with validated, up-to-date data and that information flows are controlled and traceable throughout the project lifecycle.

The BIM data exchange requirements must define how and when information is delivered, including the identification of key milestones, deliverables, and responsible parties. Each information exchange should follow a structured process of creation, review, approval, and sharing, in line with the information delivery cycle established in ISO 19650.

In addition, the format of BIM data must be standardized to guarantee interoperability between different disciplines and software platforms. Commonly accepted formats include open standards such as IFC (Industry Foundation Classes) for model exchange and COBie for asset and facility management information. These formats enable consistent data exchange and reduce the risk of information loss or incompatibility.

All exchanged information must comply with predefined naming conventions, classification systems, and metadata requirements, ensuring proper identification, version control, and traceability of information. ISO 19650 requires that each information container (models, documents, or datasets) includes standardized metadata such as author, revision, status, and date. [inesa-tech.com]

Overall, this section establishes the framework for reliable digital communication and data exchange, ensuring data consistency, coordination between project participants, and the effective implementation of BIM processes.

• Collaboration Procedures

This section defines the procedures and workflows that govern collaboration among project participants within a BIM environment. Its objective is to ensure that all stakeholders work in a coordinated and consistent manner, enabling efficient information sharing, reducing conflicts, and improving overall project performance.

Collaboration shall be structured through the use of a Common Data Environment (CDE), which provides a shared platform for storing, managing, and exchanging information. The CDE enables multidisciplinary teams to access validated data, maintain version control, and ensure that all participants work with the most up-to-date information.

The collaboration procedures must clearly establish:

- Workflows for model development, coordination, and validation
- Procedures for model federation and interdisciplinary coordination
- Methods for issue detection and resolution (e.g., clash detection processes)
- Communication channels and coordination meetings (e.g., BIM coordination meetings)
- Approval and review processes for models and associated information

These procedures align with the structured information management approach defined by ISO 19650, which emphasizes coordinated workflows and controlled information exchange throughout the project lifecycle.

In addition, collaboration protocols must define how different disciplines interact during model development, ensuring consistency in modeling standards, data structure, and level of information. This includes adherence to shared guidelines such as modeling conventions, classification systems, and agreed levels of information need.

Regular coordination activities, such as model reviews and clash detection sessions, are essential to identify and resolve conflicts at early stages, minimizing rework and improving project efficiency. All identified issues should be tracked and managed using agreed workflows and digital tools within the CDE.

Collaboration procedures should be established at the early stages of the project and continuously reviewed and updated to reflect changes in team structure, project scope, or BIM requirements. This ensures that collaboration remains effective and aligned with project objectives throughout the entire lifecycle. Below are several examples of collaboration procedures.

- Model coordination workflow: Defines how models from different disciplines are developed and coordinated.
- Clash detection process: Establishes how conflicts between models are identified and resolved.
- BIM coordination meetings: Regular meetings to review progress and coordinate decisions among teams.

The Model Content Requirements section in a BIM Execution Plan defines:

- The specific information that must be included in the model,
- The stage at which this information should be available,
- The required level of development (such as LOD or Level of Information Need)*
- BIM Uses it is intended to support.

By clearly establishing these parameters, the BEP ensures that model elements are developed consistently and progressively throughout the project lifecycle. This structured approach guarantees that the information provided is relevant to the needs of each phase, avoiding both insufficient detail and unnecessary data.

As a result, the model becomes a reliable source of information that can be effectively used for coordination, analysis, and decision-making. Furthermore, aligning model content with the defined BIM objectives ensures that all deliverables contribute directly to achieving the project goals, enhancing overall efficiency and reducing the risk of errors or misinterpretation among project participants.

*Note: The **Level of Development (LOD)** and the **Level of Information Need (LOIN)** are frameworks used to define how much information a BIM model must contain and how reliable that information is at each stage of the project.

- **LOD (Level of Development)** refers to the degree of detail, accuracy, and reliability of a model element, indicating how much it can be trusted for tasks such as design, coordination, or construction.
- **LOIN** (Level of Information Need), defined in ISO 19650, focuses on specifying the exact amount and type of information required at a given stage, ensuring that models include neither insufficient nor excessive data

With the introduction of the Level of Development (LOD), many professionals tend to overload models with excessive detail in order to avoid missing information, often including unnecessary data.

To address this issue, ISO 19650-1 introduces the concept of **Level of Information Need (LOIN)**, which goes beyond the traditional LOD approach. Instead of focusing only on the characteristics of an object, LOIN defines what information is actually required based on specific project needs and conditions.

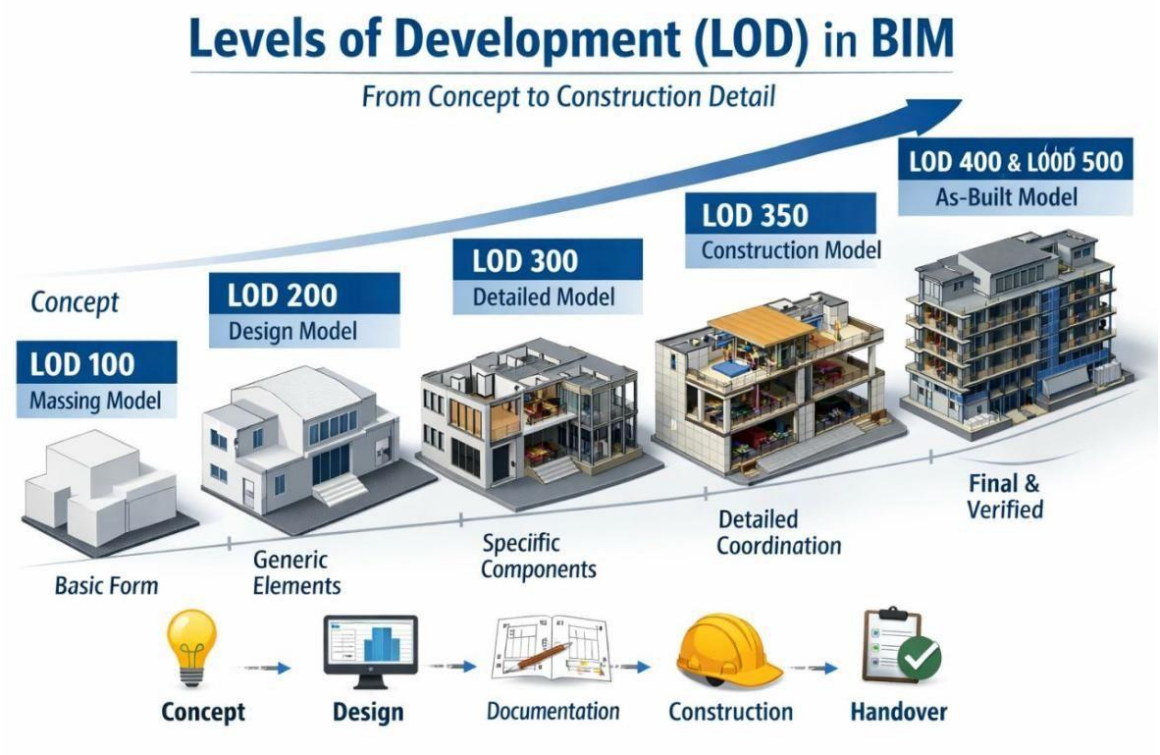


Ilustración 12. From Concept to Construction Detail. https://www.linkedin.com/posts/tosapon-prasad_bim-lod-from-concept-to-construction-activity-7458708129539600384--__S

To summarize the BEP concept, you can watch the following video:
https://drive.google.com/drive/folders/151po7JymM5N6Q70CjQGUB_2fizIdBpvE?usp=sharing

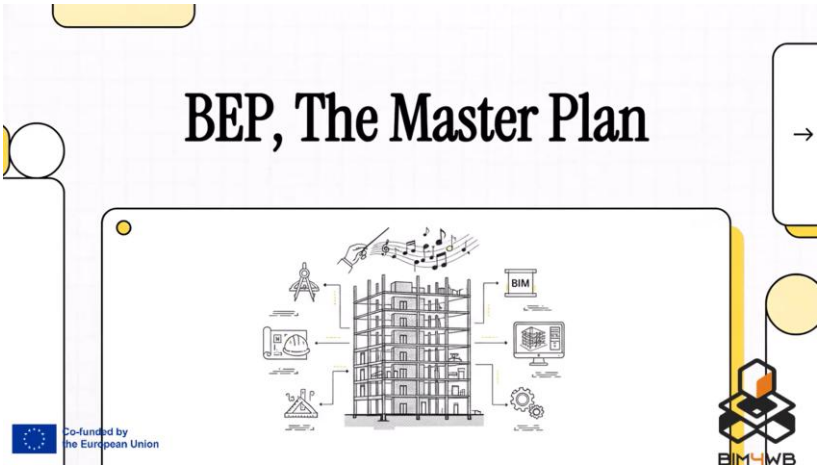


Ilustración 12. BEP, The Master Plan. NoteBookLM

1.6 Final Exam

1. Which decade is associated with the introduction of parametric modeling, allowing the modification of entire models through defined relationships rather than individual elements?

A) 1960s

B) 1970s

C) 1990s

D) 2010s

2. In the BIM multidimensional framework, which dimension is specifically dedicated to construction scheduling and time-related information?

A) 3D

B) 4D

C) 5D

D) 6D

3. According to the "BIM–BAM–BOOM" concept, where is the most expensive and complex stage to implement changes in a project?

A) During the operation and maintenance phase (BOOM)

B) During the construction assembly phase (BAM)

C) During the initial design phase (BIM)

D) During the pre-concept research phase (1D)

4. Which software is primarily described as a coordination and review tool used to aggregate models for clash detection and 4D simulation?

A) Autodesk Revit

B) Graphisoft Archicad

C) Autodesk Navisworks

D) Autodesk Docs

5. What is the primary purpose of the open BIM standard known as Industry Foundation Classes (IFC)?

A) To serve as a proprietary modeling software for architects.

B) To manage project payroll and human resources.

C) To enable the exchange of structured information between different software without losing data integrity.

D) To create immersive virtual reality environments for clients.

6. What is the fundamental difference between the IFC format and the COBie standard within the BIM ecosystem?

A) IFC is a proprietary format, while COBie is an open standard.

B) IFC focuses on exchanging structured geometric and relationship data, while COBie focuses on structured delivery of non-geometric asset data for maintenance.

C) IFC is used exclusively in the construction phase, while COBie is used exclusively in the design phase.

D) COBie is a common data environment (CDE), while IFC is a modeling software tool.

7. Following the latest revisions to ISO 19650 terminology, what is the new name for the document traditionally known as the BIM Execution Plan (BEP)?

A) Master Information Delivery Plan (MIDP)

B) Information Exchange Protocol

C) Information Delivery Milestone

D) Information Production Plan (PPI)

8. How many collaborative meetings are typically recommended in the standard timeline for developing a BIM Execution Plan?

A) Four meetings

B) Two meetings

C) One meeting

D) Six meetings

9. What is the main difference between Level of Development (LOD) and Level of Information Need (LOIN)?

A) LOD is for construction, while LOIN is only for design.

B) LOD is an open standard, while LOIN is proprietary.

C) LOIN focuses on specifying the exact amount of information required based on specific needs to avoid data overloading.

D) There is no difference; they are two names for the same concept

10. Which BIM role is primarily responsible for ensuring all project teams are aligned with goals and resolving technical issues across various disciplines?

A) BIM Facility Manager

B) BIM Manager

C) BIM Modeler

D) BIM Coordinator

1.8 List of References

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Module 2

1. Design Phase (2D)

This document presents an application and curriculum guide for a 16-hour training module entitled Design Phase 2D in AutoCAD. The course provides a structured introduction to computer-aided design (CAD) as a key methodology within the architecture, engineering, and construction (AEC) sector, focusing on the development of two-dimensional technical drawings.

The training covers fundamental principles of digital drafting, including the use of essential drawing and editing tools for the creation and modification of geometric entities. It also addresses the organization and standardization of drawings through the application of layers, visual properties, and annotation systems, ensuring clarity, precision, and compliance with technical conventions.

In addition, the module introduces strategies to improve productivity and consistency, as well as the practical application of CAD skills in the production of technical documentation such as plans, sections, and views. Finally, it incorporates basic file management and interoperability processes to facilitate the exchange of information across different formats and platforms.

Overall, this module aims to develop the core competencies required to produce accurate and professional 2D CAD drawings, supporting effective participation in the design phase of construction projects.

1.1 Objectives

Understanding 2D CAD Fundamentals: introduce the core concepts, principles, and working environment of AutoCAD, enabling learners to become familiar with digital drafting as a fundamental tool in the design phase.

Applying Drawing and Editing Techniques: develop the ability to create, modify, and manage geometric entities using essential drawing and editing commands, supporting accuracy and efficiency in technical drawing production.

Organizing and Annotating Technical Drawings: provide the competencies to structure, standardize, and document drawings through the use of layers, visual properties, dimensioning, text, and reusable elements, ensuring clarity and compliance with technical conventions.

Producing and Managing Technical Documentation: enable learners to generate complete 2D technical drawings (plans, sections, and views) and manage file interoperability through import/export processes, supporting integration within professional workflow

1.2 Learning Methodology

The methodology adopted in this module is based on a practice-oriented and active learning approach, following a learning-by-doing model widely used in vocational education. Each session combines brief instructor-led explanations with hands-on practice, allowing learners to immediately apply the demonstrated concepts using AutoCAD.

Students develop their skills through progressively structured exercises, reinforcing technical understanding and promoting autonomy in problem-solving. This approach is supported by written materials and access to official guides, enabling learners to consolidate knowledge and engage in self-directed learning.

Overall, the methodology aims to ensure the gradual acquisition of practical competencies, fostering both technical proficiency and confidence in the development of 2D CAD drawings.

Learning Outcomes:

1. Understands the AutoCAD interface and explains basic concepts of two-dimensional technical drawing.
2. Applies basic drawing commands (line, circle, rectangle, polyline) to create technical drawings.
3. Uses editing commands (move, copy, offset, trim, extend) to modify and improve drawings.
4. Organizes drawings through layers, color, and line type settings.
5. Applies dimensioning and text tools (Text, Mtext, Dimension) accurately in technical drawings.
6. Creates hatches and blocks to enrich and standardize drawing content.
7. Produces technical drawings of plans, sections, and views according to architectural and engineering requirements.
8. Performs DWG–PDF and DXF import/export operations to support information exchange in digital construction workflows.
9. Understands the role of 2D drawings within BIM-based digital construction processes.

1.3 Training Duration

The application described in this guide will be carried out through self-regulated learning via the BIM4WB platform.

This training is a total of **16 lecture** hours.

1.4 Required Teaching Resources

Hardware requirements: computer lab equipped with computers with access to multimedia and the internet.

Software required: Autodesk AutoCad

1.5 Course Content

All the videos and supporting documents mentioned can be found in the following link: https://drive.google.com/drive/folders/179ac209r0VSOwjKqJXLqwYYnpByGaSTQ?usp=sharing

1.5.1 Unit 1

1.5.1.1 V1. Interface Introduction and Basic Concepts

This working document has been designed as an educational complement to the video **"V1. Interface Introduction and Basic Concepts",** organizing key concepts in a structured way to facilitate learning of the two-dimensional user interface.

1. **Start Screen and Document Access**

When starting the software, we encounter a management center strategically divided. The left column is the operational core for the initial configuration of any project. When launching AutoCAD 2026, the screen is divided into specific areas for file management:

- **Left Panel:** Allows opening existing documents or creating a new one based on a template.
- **"New" Icon:** Located both on the central screen and in the top bar (blank sheet icon), it allows quick access to new blank drawings.
- **Recent Documents:** The central area displays previously worked files. They can be organized by name or last opened date and viewed in list format or as thumbnails.
- **Top Tab:** Using the "+" symbol, a new blank workspace can be quickly enabled.

2. **Work Interface: The Ribbon**

The Ribbon is the command center. Its logical architecture organizes tools into tabs and groups to avoid cognitive overload for the designer. Once a drawing is opened, editing tools are activated:

- **Ribbon:** Located at the top, it contains tabs (Home, Insert, Annotate, etc.). It is the main tool for drawing and project management.
- **Tabs and Groups:** Contain tools for drawing, modifying, dimensioning, creating blocks, managing properties, and groups.
- **Drop-down Triangles:** Many tools include a small triangle which, when clicked, provides additional options such as trim, extend, array, or text editing.

3. Access and Navigation Bars

Navigation in 2D requires full control over what we see and from where we see it:

- **Quick Access Toolbar:** Located at the top, it provides quick access to functions such as "Save". It can be customized by enabling/disabling icons and changing its position above or below the Ribbon.
- **View Tab:** This is the visual control center. It allows configuring the visibility of elements on screen such as:
    - The coordinate origin icon (UCS).
    - The Navigation Cube (more useful in 3D).
    - The Navigation Bar (side panel with Zoom and Pan tools).
- **Viewport Configuration:** Crucial for complex projects. It allows dividing the screen into up to four sections, enabling observation of a construction detail in one window while maintaining an overall view in another. From this tab, different windows can be managed simultaneously to monitor all project details.
- **Visual Navigation:** Although the Navigation Cube includes predefined views (top, front, etc.), its usefulness stands out in 3D. For 2D workflows, the Navigation Bar (zoom and pan) is the essential tool for agile movement.

4. Project Management and Workspaces

The professional workflow is divided into two distinct environments through the lower tabs:

- **File Tabs:** Located at the top of the drawing area, they indicate which projects are open and allow switching between them or opening new ones.
- **Model Space vs. Paper Space:** Tabs located at the lower left:

- **Model Space:** It is an infinite workspace. Here, drawing is carried out strictly at real scale (1:1), concentrating all the technical and engineering aspects of the project. This is where technical drawing is performed.
- **Paper Space (Layout):** The workspace for subsequent printing. Final sheets are prepared here, print scales are adjusted, and information is organized for professional delivery. It is used to prepare and layout the final drawings of the project.

5. Commands and Status

To interact with these environments, two communication channels are available:

- **Command Line:** The communication center with the software. Commands are entered directly, or step-by-step instructions are followed to execute actions. It is not just a text line; it is a guide providing sequential instructions. If the "Line" command is activated, the command line indicates exactly what data the program requires to continue.
- **Status Bar:** Located at the bottom right, it allows customization of the environment by activating "toggles" or helper icons to streamline workflow. It is essential to configure which icons are visible to avoid a workspace overloaded with unnecessary functions.

6. Help and Advanced Configuration

A technically accurate drawing requires a configuration that protects both the designer's view and data integrity:

- **Help Window:** Located in the upper right, it allows searching for keywords that redirect directly to the official Autodesk website.
- **Options Menu:** Allows customization of the user experience:
  - **Background color:** Adjust tones to reduce visual fatigue after long hours of design.
  - **Selection size and Snaps:** Increasing the size of snap points is essential to ensure precision when working on high-resolution monitors, avoiding millimetric errors when closing polygons.
- **Drawing Units Control:** This is the most critical step to avoid scaling issues in architectural drawings. AutoCAD often defaults to millimeters; if the project is architectural, the DWGUNITS command must be used and code 6 (meters) selected. This ensures that 1 drawing unit equals exactly 1 meter, allowing print scales to function correctly in paper space.

7. Practical exercise

Open AutoCad 2026 software and explore all the areas indicated in the drawing, trying to identify them and testing all the tabs and areas shown in the video.

8. Self-Assessment Checklist: V1. Interface Introduction and Basic Concepts

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V1. Interface Introduction and Basic Concepts	Identify the main areas of the start screen and manage files (new, open, recent)		
	Use the Ribbon correctly (tabs, groups and tools)		
	Navigate the workspace using Zoom, Pan and visualization tools		
	Distinguish between Model Space and Paper Space		
	Use the command line correctly		
	Manage workspace configuration (status bar, units, settings)		

1.5.1.2 V2. Basic Drawing Commands (Line, Circle, Rectangle, Polyline)

This working document serves as a study guide and support material for the video **"V2. Basic Drawing Commands"** It details the essential tools of the **Home tab**, the use of the **command line**, and coordinate systems for precise technical drawing.

1. Introduction and the Draw Panel

The fundamental tools for starting to draft are located in the **Ribbon**, specifically in the **Home tab**, within the **Draw panel**.

- **Command Line:** It is essential to follow the instructions displayed in it, as it guides the user step by step on what data to enter (points, distances, or angles).

2. Drawing Commands: Line and Polyline

Although they may appear visually similar, the structural difference between a **line** and a **polyline** is fundamental for professional editing of a drawing, as their structural behavior is different:

- **Line (LINE):** Creates independent segments. When selecting a square made with lines, only the individual and isolated segment is selected, requiring each segment to be selected separately.
- **Polyline (PLINE):** Creates a single, unified object. When any part of the polyline is selected, the entire geometry is selected, facilitating actions such as deleting, copying, or creating offsets. It allows creating a parallel contour of the entire figure with a single operation.

Coordinate Systems and Precision

- **Cartesian Coordinates:** To start at the exact origin, enter **0,0 (X, Y)** in the command line.
- **Polar Coordinates and Cursor Constraint:** These allow drawing at specific angles. **Polar Tracking** can be configured to display angles such as 45° or 90° using a green guideline.
- **Close and Undo:**
    - **Undo:** Type the letter **U** or select "Undo" in the command line.
    - **Close:** To complete a polygon by returning to the initial point, use the letter **C (Close)**.
    - **Exit a command:** Press **Enter** or the **Escape key**.

3. Your First Drawing: Line and the Coordinate Origin (0,0)

Technical drawing requires absolute accuracy. To ensure this, we use the **Cartesian coordinate system (X, Y)** starting from the absolute origin of the workspace.

Steps to create a square of 100 units per side:

- **Activate command:** Click on "Line" or type **LINE** in the command line.

- **Starting point:** When prompted for the first point, type **0,0** and press Enter.
- **First segment (Right):** Type **100,0** (100 in X, 0 in Y) and press Enter.
- **Second segment (Up):** Type **0,100** (0 in X, 100 in Y) and press Enter.
- **Third segment (Left):** Type **-100,0** (-100 in X, 0 in Y) and press Enter.

Closure and Exit:

To complete the figure, there are three options:

- Type **"C" (Close)** so the program automatically connects the last point to the origin.
- Click on the initial point (**0,0**).
- Enter the final coordinates **0,-100**.
- **Finish:** Press **Escape** (once or twice) or **Enter** to exit the command.

The precision of these straight lines is the foundation required to address angle customization and angular geometry.

4. Complex Geometric Figures

Circle and Arc

The creation of curves is based on the available geometric data. The software provides multiple methods to adapt to design requirements depending on the known parameters:

- **Center/Radius:** Specify the center point and define the distance to the edge (e.g., Radius 50 for a total diameter of 100).
- **Center/Diameter:** A direct method when the total diameter is known.
- **3-Point Arc:** Allows drawing a curve by specifying the start point, an intermediate point, and the endpoint.
- **Arc (Start/Center/Angle):** Provides high visual control, as curvature adjusts dynamically according to cursor orientation before confirming the angle.

Rectangle and Polygon

The **Rectangle** command enables quick creation by defining the first point and then specifying dimensions in X and Y (e.g., 20,10). It also includes advanced options such as **Area** (to define size based on total surface) and **Rotation** (to orient the rectangle away from the horizontal).

- **Rectangle (RECTANG):** Defined by specifying a first point and then dimensions in X and Y (e.g., 20x10). It also allows applying rotation before completing the drawing.
- **Polygon (POLYGON):** Allows a variable number of sides (e.g., a triangle has 3 sides, a pentagon 5, etc.).
    - **Inscribed:** The polygon fits inside an imaginary circle.
    - **Circumscribed:** The polygon surrounds the imaginary circle.

Procedure:

- **Geometry:** Enter number of sides → Defines the polygon type (e.g., 5 for pentagon).
- **Reference:** Specify Center or Edge → Choose between a radius or the length of a side.
- **Radial Method:** Select Inscribed or Circumscribed → Determines whether the polygon is inside or outside an imaginary circle.
- **Dimension:** Specify Radius → Establishes the final size of the figure.

Ellipse

Ellipses are primarily generated using two methods:

- **Center method:** Define the center and the two radii.
- **Axis/End method:** Define the full length of one axis and then the opening of the second axis.

5. **Auxiliary Tools: Construction Line**

The **Construction Line (XLINE)** is an infinite auxiliary line used as a reference for aligning objects.

- **Purpose:** It is essential for projecting columns, walls, or ensuring that different parts of a drawing (such as two rectangles) are aligned at the same height.
- **Options:** It can be configured as horizontal, vertical, or at a specific angle.

- **Structural Alignment**: If you need to position a series of columns or rectangles at exactly the same height across an extensive plan, draw a horizontal construction line. This infinite guide allows objects to be aligned to a common reference, ensuring that the design maintains perfect technical alignment from one end to the other.

6. Practical exercise.

Based on the attached file, try to replicate the existing drawing using the tools learned in the lesson.

File name: M2_V2. Exercise

7. Self-Assessment Checklist: V2. Basic Drawing Commands

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V2. Basic Drawing Commands	Create basic geometry (line, circle, rectangle)		
	Use coordinate input (Cartesian or polar)		
	Differentiate between line and polyline		
	Apply precision tools (close, undo, tracking)		
	Generate basic geometric compositions correctly		

1.5.2 Unit 2

1.5.2.1 V3. Editing Commands (Move, Copy, Offset, Trim, Extend)

This document has been designed as a teaching guide to accompany the video **"V.3 Editing Commands"** focusing on the **Modify panel** within the **Home tab** of AutoCAD 2026. These tools are essential for editing existing geometry with professional precision.

1. **Displacement and Duplication Operations**

- **Move:** Allows changing the position of an object.
    - **Procedure:** Select the icon or type the command → Select the object → Confirm (right-click or Enter) → Choose a base point (grip point) → Specify the destination point.
- **Copy:** Operates identically to the Move command but retains the original object. In AutoCAD 2026, multiple copy mode is typically active by default, allowing several copies of the object to be placed using the same base point until the Escape key is pressed.
- **Rotate:** Rotates objects around a base point. To rotate an object, select it, confirm, and define the base point that will act as the rotation axis.
    - **Precision:** Polar Tracking can be used for common angles (15°, 30°, 45°), or the exact value can be entered manually (e.g., 23°) in the command line. When a non-standard angle is required, manual input ensures mathematically precise orientation.

2. **Shape and Scale Transformations**

- **Mirror:** Works as an imaginary mirror. It is ideal for creating identical symmetrical parts, reducing drawing time by approximately 50%. It generates an inverted copy of the object relative to a defined axis.
    - **Key aspect:** It is essential to define a symmetry axis (usually based on midpoints of other elements). At the end of the command, the program prompts whether to delete the original object or keep both. Always select a geometrically meaningful base point (such as a corner or a center) to ensure precise results.

- **Scale:** Allows resizing objects proportionally through numerical input.
    - **Scale factor:** Entering 0.5 reduces the object to half its size; entering 2 doubles its original size.

3. Trimming and Extending Tools

These tools depend entirely on the drawing context.

- **Trim and Extend:**
    - **Extend:** The selected line is automatically extended to the nearest boundary. When hovering the cursor over a line, it previews extension toward the nearest element in that direction. The extension direction depends on where the user clicks relative to the segment.
    - **Trim:** Allows removing excess segments by detecting the nearest cutting edge. An advanced technique consists of drawing a transversal line across multiple elements to trim several segments in a single operation, saving time.
- **Lengthen:** Although available as a command, geometry can also be modified interactively using grips (snaps). It is recommended to select the object and drag the blue grips to stretch or shorten lines more intuitively.

4. Intersections and Corners

- **Fillet:** Joins two lines using an arc, configured with the **Radius (R)** option.
    - **Zero radius:** When set to 0, it produces a perfect right angle (90°).
    - **Defined radius:** When a value is specified (e.g., radius 10), the lines are joined with a rounded curve.
- **Chamfer:** Creates a beveled edge, as if making an angular cut. It is configured using distances.
    - **Configuration:** Requires defining two distances (e.g., 12 and 10) to determine the slope of the bevel. As with Fillet, using a distance of 0 allows quickly closing open corners.

5. Organization and Decomposition

When workflows become repetitive or when it is necessary to break down complex elements, the following commands are used:

- **Array:** Creates ordered repetitions of an object. When activated, it opens a contextual tab in the Ribbon to configure the number of rows, columns, and spacing. It enables precise control of distances and layout, automating the creation of grids or repeated elements.
- **Explode:** Breaks down a complex object (such as a polyline or a block) into individual elements (simple lines). A unified object becomes independent segments (e.g., a rectangle becomes four separate lines).
- **Offset:** The essential tool for creating parallel lines or wall thicknesses. The user specifies the distance and selects the object; the command generates an exact parallel copy at that distance on the chosen side. It is a fundamental tool for drafting walls or parallel geometries efficiently.

When applying all these commands, it is essential to carefully read the prompts displayed in the **command line**. If the command requests “specify radius” or “select axis,” the command line provides the necessary options (including highlighted shortcut letters) to guide the user through the process accurately.

6. Practical exercise.

Based on the attached file, try to replicate the existing drawing using the tools learned in the lesson.

File name: M2_V3. Exercise

7. Self-Assessment Checklist: V.3 Editing Commands

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V.3 Editing Commands	Move and copy objects correctly		
	Apply offset and create parallel elements		
	Trim and extend geometry efficiently		
	Use transformations (rotate, mirror, scale)		
	Modify geometry with precision using command tools		

1.5.3 Unit 3.

1.5.3.1 V4.Layers, Color and Line Type Settings

This material has been developed as a teaching guide complementary to "**V4. Layers, Color and Line Type Settings"**, providing detailed written support that follows the logical structure of the lesson to facilitate learning.

1. **Fundamentals of Layer Organization**

Efficient layer management is the foundation of organization in any professional technical drawing. Its primary purpose is to facilitate **visibility management, efficient editing, and precise printing control**.

Layer control is centralized in the **AutoCAD Ribbon**, specifically within the tools dedicated to layers. When opening the **Layer Properties Manager**, a workspace is accessed where new drawing layers can be created and critical parameters defined, such as:

- **State:** on/off
- **Visibility:** freeze/thaw
- **Security:** lock/unlock
- **Plotting:** whether the layer is printable or not

Additionally, visual and technical properties are defined, including **color, linetype (continuous or dashed), lineweight, and transparency**.

2. Fundamental Rules for Professional Organization

For a drawing to be correctly interpreted by any technician, it is essential to maintain a rigorous organizational criterion.

To achieve a clear visual hierarchy, the following principles must be applied:

- **Mandatory Differentiation:** It is essential not to draw all elements in a single layer; separation enables efficient and flexible drawing management.
- **Visual Identification by Color:** Using different colors for each layer allows instant recognition of the displayed elements.
- **Lineweight Hierarchy:** The same lineweight should not be used for all elements. Hierarchical differentiation (e.g., walls vs. furniture) is essential for correct interpretation in printed drawings.
- **Layer 0 Restriction:** "Layer 0" must be reserved exclusively for importing elements or creating blocks/objects. It should not be used for general project drawing.

3. Standard Naming Protocol

To ensure interoperability in international projects, a rigorous and descriptive naming convention must be followed to clearly identify the content of each layer.

A professional drawing requires **descriptive layer names** that clearly define their content, always separating geometry from text and dimensions, following international standards (similar to **ISO or AIA conventions**).

All properties must be configured using the **"ByLayer" criterion**. This ensures that any global change to a layer automatically affects all its elements, maintaining drawing integrity.

This means that the **color, linetype, and lineweight of each object must be linked to its layer**. For example, if the color of all walls needs to be modified, changing the layer property will

automatically update all associated elements, ensuring full consistency of the technical documentation.

Layer Naming Structure

The suggested standard follows a hierarchical format:

Discipline – Element – Specification

1. **Discipline (Prefix):**
    - **A:** Architecture (e.g., walls, joinery)
    - **S:** Structure (e.g., columns, footings)
    - **E:** Electrical systems (e.g., lighting, wiring)
2. **Element:** Object description (e.g., WALL, COLUMN, LIGHTING)
3. **Specification (Suffix):** Additional detail (e.g., INT for interior, EXT for exterior, P1 for first floor)

Practical Examples

- **Architecture (Prefix A):** Interior walls are named **A-WALL-INT**. Walls are typically sectioned elements, so they use a thicker lineweight (e.g., 0.30 mm) and a continuous line. Exterior walls may use **A-WALL-EXT** with a different color for quick distinction.
- **Structure (Prefix S):** Used for elements such as columns or foundations. A clear example is **S-COLUMN-P1** for first-floor columns, typically using colors such as green and lineweights around 0.30 mm to represent sections.
- **Electrical Installations (Prefix E):** Used for lighting and wiring systems (e.g., **E-ELECTRICITY-LIGHTING**). These elements generally require the thinnest available lineweights (e.g., 0.00 mm) to avoid visual overload in the drawing.

4. Advanced Management Tools for Complex Projects

In large-scale projects with numerous layers or international collaboration, filtering and management tools are essential to maintain order and efficiency:

- **Group Filters:**

Allow grouping layers by categories (e.g., Architecture, Structure, Electrical) to quickly locate and manage them without affecting the rest of the list.

- **Dynamic Visibility Management:**

Commands allow visibility control without opening the Layer Manager:

  - **LAYOFF:** Turns off layers by selecting objects directly in the drawing.
  - **LAYON:** Restores all layers simultaneously.
  - **LAYISO:** Isolates selected layers to work efficiently on specific areas.

- **Match Properties:** It is essential to always define the current working layer to avoid mixing elements and maintain drawing clarity. If errors occur, the **Match Properties** command allows copying layer properties from a reference object to others, ensuring proper organization and consistency.

5. Technical Conclusion

A professional technical drawing is not only defined by its geometric precision but also by the rigor of its internal structure.

Compliance with these layer standards ensures that drawings are **clearly readable for any international collaborator**, facilitating multidisciplinary coordination and accurate execution during construction.

6. Practical exercise.

Using the attached file as an example, try to create all the existing layers in the model, and apply all the characteristics indicated in them.

File name: M2_V4. Exercise

7. Self-Assessment Checklist: V4. Layers, Color and Line Type Settings

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V4. Layers, Color and Line Type Settings	Create and organize layers correctly		
	Assign objects to appropriate layers		
	Apply visual properties (color, linetype, lineweight)		
	Control layer visibility and locking		
	Use structured naming and ByLayer properties		

1.5.3.2 V5.Dimensioning and Writing Text (Text, Mtext, Dimension)

This teaching material has been designed as a study guide to accompany "**V5.Dimensioning and Writing Text"**. Its objective is to serve as written support, following the same structure as the lesson to facilitate the learning of annotative elements in AutoCAD.

1. **The Annotation Group**

Within the AutoCAD ribbon, the Annotation group is the control center for adding written and dimensional information to the drawing. The two fundamental pillars of this group are:

- **Text**: To name spaces or elements.
- **Dimensions**: To indicate real measurements and sizes.

Mastering the communication of data through text is the first essential step in giving meaning to the drawn geometry. The integration of these components is essential for the technical drawing student for three operational reasons:

- **Communicative clarity**: Eliminates ambiguity about the function of each object or space.

- **Metric precision**: Provides exact magnitudes, preventing the final user from having to take manual measurements from the drawing.
- **Professional standardization**: Ensures that the document complies with international standards, guaranteeing universal readability.

2. Types of Text: Single Line vs. Multiline

Not all text in a technical project requires the same structural complexity. There are two main ways to introduce text, each with a specific use:

- **Single-Line Text**: Used for brief elements, such as numbering or simple labels. It is more rigid; when editing, you can generally only change the word content, and to modify its format (such as height or justification), it is necessary to open the Properties window or use specific editing commands.

The creation of Single-Line Text requires a sequence of two initial clicks: the first defines the insertion point and the second establishes the direction or height of the text. It is an agile tool for specific data, although its editing is limited to the text itself unless the editing window is accessed to modify justification (left, center, right) or height.

- **Multiline Text**: This is the most versatile option for paragraphs or longer descriptions. When creating a text box, an editing window similar to a word processor (such as Word) automatically opens, allowing you to change fonts, apply bold, italics, strikethrough, or center content intuitively.

Multiline Text is based on defining a container or “text box,” so when this box is activated, the software displays a top ribbon similar to that of a word processor.

For any later modification, the standard procedure is to double-click the element, which activates the editing environment to update terms (for example, changing “Door” to “Window”) immediately. Once textual expression is mastered, the professional must address the precise representation of the drawing’s physical magnitudes.

To maintain consistency in the project, you can use the **Match Properties** tool to copy the style from a reference text to other texts in the drawing.

3. Layer Management for Annotations

The organization of a project is a key element in achieving a good result. It is recommended professional practice to select the appropriate layer before starting to write or dimension.

- A specific layer is usually used (for example, called “Dimensions” or “Texts”) to separate drawing geometry from written information.

4. The Dimensioning System

Dimensioning is the act of translating geometry into measurable dimensional information. Dimensions allow you to measure objects in the drawing. AutoCAD offers different tools depending on the shape of the element. The selection of the appropriate dimension type strictly depends on the nature of the object:

Dimension Type	Application
Linear	Used for orthogonal measurements, strictly horizontal or vertical, relative to the drawing axes, regardless of their inclination.
Aligned	Essential for inclined objects, as it measures the true distance parallel to the element’s inclination, not just its projection, placing itself perpendicular to the element.
Angular	Determines the exact opening in degrees resulting from the intersection of two lines. Measures the angle formed between them.
Arc Length	Measures the curved path of a circular segment over its entire length, unlike the linear distance between its endpoints. Indicates the total dimension along the arc path.
Radius and Diameter	Used for circles. The system automatically inserts the prefixes R for radii and Ø for diameters, optimizing production speed and drawing clarity, avoiding confusion.

It is common that, when applying these tools for the first time, the size of the dimension is not visually harmonious with the drawing. In such cases, the solution does not lie in modifying each individual dimension, but in the proper management of styles.

5. Customization and Dimension Styles

The discipline of technical drawing requires aesthetic uniformity. To achieve this, professional workflow avoids using generic settings, opting for the creation of custom styles based on standards such as **ISO 25**.

Sometimes, default dimensions (such as the ISO-25 style) may appear too large or too small in relation to the drawing. To solve this, you must access the **Dimension Style Manager**:

1. **Create a New Style**: It is recommended to create a new style based on an existing one (for example, creating a new style "NewDimensions E100" from the ISO-25 style) in order not to alter the defaults.
2. **Editable Parameters**: The software provides a dynamic preview window on the right that shows changes in real time, facilitating the adjustment of a series of critical parameters. The most notable are:
    - **Symbols and arrows**: Allows replacing closed arrows with architectural tick marks or other predefined symbols, improving visual cleanliness.
    - **Text**: Adjust the text height so that it is proportional to the drawing (for example, reducing from 25 to 10). This ensures the annotation is readable without obstructing the geometry.
    - **Units**: Defines the number of decimals and the use of decimal separators (dot or comma) according to local standards.
    - **Extension lines**: Adjusts the distance between the drawn object and the start of the dimension line.
3. **Apply**: For these changes to take immediate effect in the workflow, it is imperative to use the **"Set Current"** option. This ensures that each new dimension automatically inherits the properties of the custom style.

Remember that annotation must always be clear and proportional. It is not enough for the measurement to be correct; it must be on the appropriate layer, with a readable text style and a dimension scale that allows it to be read without overcrowding the technical drawing.

6. Practical exercise.

Using the attached file as an example, create text and dimensions as indicated on the left side of the drawing. To do this, create new text and dimension layers, as well as your own custom dimension type..

File name: M2_V5. Exercise

7. Self-Assessment Checklist: V5. Dimensioning and Writing Text

Video Code and Title	**Technical Criteria to be Checked**	**Status (Y/N)**	**Instructor Note / Score**
V5.Dimensioning and Writing Text	Insert and edit text elements correctly		
	Differentiate between single-line and multiline text		
	Apply dimension tools according to geometry		
	Use and adjust dimension styles		
	Ensure clear and readable annotations		

1.5.3.3 V6. Hatch and Block Creation

This teaching material has been designed as a study guide to accompany "**V6. Hatch and Block Creation**". This document synthesizes the technical procedures for creating libraries and

applying textures, following the logical structure of the lesson to ensure smooth and professional learning.

1. Introduction and Block Management

Efficiency in technical drawing depends on the ability to reuse elements. To manage these libraries, AutoCAD provides a specific set of tools on the ribbon known as the **Blocks panel**.

Imagine a sofa composed of 58 independent lines; manipulating it without organization is inefficient and prone to errors. A **block** transforms this set into a single entity. From this panel, users can access different insertion sources:

- **Existing Blocks**: Elements already defined within the current drawing.
- **Recent and Favorites**: Quick access to the most frequently used elements.
- **Block Libraries**: Access to external files stored on the computer, facilitating standardization across different projects.

2. What is a Block? Concept and Advantages

A **block** is a group of lines and geometries that behave as a single entity. Instead of managing dozens of individual lines to represent an object (such as a sofa or table), a block allows them to be treated as a unified object.

Main advantages:

- **Efficient Management**: Move, copy, or rotate complex objects with a single action.
- **Optimization**: Reduces file size and simplifies element selection in dense drawings.

3. Step-by-Step Creation Process

To convert a set of lines into a professional block, the following workflow should be followed:

1. **Object Selection**
   Select all geometries that will form the object.

2. **Create Block Command**

   Click on *Create Block* to open the block definition window, where key parameters must be configured:

   - **Name**: Assign a clear, descriptive, and technical name (e.g., *TABLE-6* for a six-person table).
   - **Base Point (Insertion Point)**: The exact point used to "grab" and place the block during insertion.
   - **Units**: It is essential to define drawing units to ensure the block maintains correct scale when inserted into other files.
   - **Additional Properties**:
     - Annotative behavior (scales according to annotation scale)
     - Uniform scaling
     - Allowing future decomposition (explode option)

4. **Block Editor and Global Updating**

One of the most powerful tools is the **Block Editor**, accessed by double-clicking any block instance.

- **Geometry Editing**: Within this environment, lines can be moved, deleted, or new elements added.
- **Automatic Updating**: When changes are saved, all instances of the block in the drawing are updated simultaneously.
  - Example: If you delete a design line in a sofa block, all identical sofas in the project will instantly reflect the modification.
- **Explode Command**: If needed, a block can be reverted into its original individual lines using the *explode* function.

5. **Hatching and Textures**

The **Hatch command** is used to fill closed areas with patterns, solid colors, or gradients, significantly improving drawing readability and interpretation.

Main types in AutoCAD:

1. **Hatch**: Line patterns or technical textures
2. **Gradient**: Color transitions for visual effects
3. **Boundaries**: Definition of fillable areas

Application Methods:

- **Pick Points**: Click inside a fully enclosed area. The software automatically detects the boundary.
- **Select Objects**: Directly select the perimeter of the shape to be filled. Ideal for predefined closed polygons.
- **Important Requirement:** The area must be completely closed. If gaps exist, AutoCAD will display an alert because it cannot detect the boundary. It is essential to verify line intersections before applying hatches.

6. **Technical Customization of Hatches**

A professional workflow always includes **Layer Management**:

- Before hatching, it is recommended to turn off text layers to avoid visual interference.
- After applying the hatch, it should be assigned to a specific layer (e.g., *FLOORS*) to maintain professional organization standards.

Once the hatch is created, an editing ribbon allows further adjustments:

Editing Properties:

- **Pattern and Color**: Choose standardized patterns (brick, earth, concrete) and assign appropriate colors.
- **Transparency**: Adjust visibility (e.g., 60%) so the hatch does not obscure other important elements.
- **Scale and Angle**:

- Scale must be adjusted for proper readability.
- Angle (e.g., 60° or -45°) defines the orientation of materials such as tiles or flooring.

Practical Example:

To create a bathroom floor:

- Select a tile pattern
- Adjust its scale appropriately
- Orient it orthogonally
- Assign it to the corresponding layer (e.g., *FLOORS*) to maintain professional standards

Final Considerations: Blocks enable standardization and efficiency in editing, while hatching provides the visual clarity necessary for accurate interpretation of technical drawings in a professional environment.

7. Practical exercise.

Using the attached file as an example, convert all furniture elements and doors into blocks, and create patterns for the different floors, as shown on the left side of the model.

File name: M2_V6. Exercise

8. Self-Assessment Checklist: V6. Hatch and Block Creation

Video Code and Title	**Technical Criteria to be Checked**	**Status (Y/N)**	**Instructor Note / Score**
V6. Hatch and Block Creation	Create and use blocks efficiently		
	Edit and manage blocks (Block Editor)		

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
	Apply hatches to closed areas		
	Adjust hatch properties (scale, angle, transparency)		
	Organize blocks and hatches using layers		

1.5.4 Unit 4.

1.5.4.1 V7. Technical Drawing Application/ Plan, Section and View Drawing

This teaching material has been designed as a study guide to **"V7. Technical Drawing Application/ Plan, Section and View Drawing".** The objective of this document is to provide a theoretical and practical foundation that faithfully follows the design process shown in the lesson, ensuring a professional and efficient workflow for international projects.

1. **Initial Setup: Working Units**

In technical drawing, clarity and order are not merely aesthetic concerns, but fundamental pillars of professional communication. An optimized workflow allows the graphical message to be understood both by specialists in the field and by people outside the technical domain.

The primary objective of this method is to achieve a drawing that is as clear and intuitive as possible, so that anyone can interpret the information without needing to ask or figure out what each element refers to, ensuring a logical representation ready for execution.

The thorough preparation of the digital environment is the first critical step to ensure the accuracy and consistency of the entire project. Before starting any drawing, it is essential to define the system we are operating in to guarantee precision and interoperability with other technicians.

- **Units Check**: Before drawing any line, it is essential to define the working scale. The DWGUnits command allows you to check and set the file's units of measurement (millimeters, centimeters, meters, or international and imperial systems) according to

the project's requirements. This step is the starting point for ensuring that the drawing maintains a real and coherent scale.

2. Layer Organization: The Professional Pillar

As seen in previous modules, layer organization is the key to good representation and what makes a drawing appear professional.

- **Classification by Scope**: Layers must be named according to what is drawn, based on their nature or area within the project (discipline prefixes: A-Architecture, S-Structure, etc.). Clear and descriptive naming of layer content is essential.
- **Technical Properties**: Colors, line types, and line weights must be assigned according to the function of each element, facilitating a readable representation.

A rigorous layer structure allows any technician to navigate the file easily, facilitating editing and the visibility of specific elements at each stage of the design process.

With the environment configured and layers established, the next step is the execution of the horizontal projection, which constitutes the basis of all technical documentation.

3. Horizontal Projection (Plans)

The drawing usually begins with the architectural floor plan, which is the standard representation showing the layout of spaces through a technical top view. This serves as the foundation upon which the rest of the project will be developed.

- **Cutting Criterion**: The building is represented through an imaginary horizontal cut. Ideally, plans are represented as if they were sectioned at mid-height (approximately at window level). In this view, critical elements such as external walls, internal walls, doors, and windows are cut.
- **Visual Hierarchy in Plans**: Visual hierarchy allows the drawing to be understood without additional explanations.
    - **Sectioned Elements**: Represent elements physically cut by the section. They are drawn with greater line thickness and more intense colors. Sectioned elements

such as walls or partitions must have a thicker line so that anyone can intuitively understand the drawing.

- **Projection Lines**: Represent elements below the cutting plane, such as floor finishes. They are drawn with thinner lines and softer colors, using hatches (such as grids for tiles) to indicate floor types without overcrowding the drawing.
- **Voids**: Technical symbol used to indicate empty spaces (such as an elevator shaft). They are marked with an "X" to indicate that it is an open or empty space with no slab in that area.
- **Hatches**: Used to improve visual understanding. In floors, a grid hatch indicates tiling. It is also highly effective to apply hatches to sectioned partitions to help visualize the cut more clearly.

4. Arrangement and Alignment of Plans

To facilitate understanding of how the building will be executed, floor plans must be drawn in their logical construction order. A professional project organizes drawings following a logical execution sequence (Basement → Ground Floor → Upper Floors (First, second, etc.) → Roof).

- **Auxiliary Construction Lines (XLINE)**: Essential tools to ensure that common elements are aligned. They are infinite axes that allow alignment of common elements such as columns, elevators, stairs, etc., both vertically and horizontally across different floors.
- **V Command**: Generates vertical lines for quick checks.
- **H Command**: Generates horizontal lines.

By drawing these auxiliary lines, we can verify whether the drawing pattern is consistent across all levels. These lines are temporary and must be deleted after verification to maintain a clean document.

Once the horizontal projection is defined, it serves as a geometric guide to accurately project the vertical views of the building.

5. Elevations (Facades)

Once the horizontal projections are defined, the elevations are created (main façade, rear façade, right and left sides). These views reveal the external volume and internal complexity of the building, always maintaining correspondence with the floor plans.

- **Height Definition**: It is essential to define the heights of each slab to establish where each floor begins and ends, as well as the total height of the building.
- **Drawing Technique**: It is recommended to place the elevation directly below the corresponding plan to take advantage of auxiliary lines and ensure that the façade geometry matches the plan elements.
- **Dynamic Navigation**: To work more efficiently and dynamically, it is recommended to reorient the model space. The ViewCube allows changing the viewpoint (for example, to the East façade) to draw side elevations directly.

Note: When rotating the view in 2D, the coordinate system does not change, so vertical or horizontal auxiliary lines must be adapted to the new viewpoint. If the view is reoriented to a side and you want to draw a line that appears vertical on screen to project the elevation, you must use the Horizontal auxiliary line command (H), since the system still recognizes the original orientation of the 2D model.

6. Sections (Cross Sections)

Sections provide crucial information about the interior of the building and the communication between floors. They are vertical cuts that are essential for understanding connections between levels.

Their location must be strategic. Although there are no strict rules, the universal recommendation is to create sections that pass through the staircase, as they show how levels connect, or through singular elements where something may be misinterpreted.

A well-executed section (both horizontal and vertical) defines the geometry of circulation elements and the internal structure, being essential for the actual construction of the building.

7. Preparation for Printing

An optimal workflow is based on accurate units, clean layer organization, and rigorous alignment between plans, elevations, and sections. The clarity of the drawing must allow anyone, technical or not, to understand it without external explanations.

Mastering these concepts and applying this structured methodology ensures that the technical document is precise, professional, and fully prepared for the final stage.

Once the complete set of plans, elevations, sections, and details is finished, the drawing is technically ready to be transferred to the Layout, where the scale and final print format will be defined.

8. Practical exercise.

Using the attached file as an example, named "complete project", in the provided working document, draw all the plans and sections of the building as shown in the attached template.

Files name: M2_V7.1 Complete project

M2_V7.2. Exercise

8. Self-Assessment Checklist: V7. Technical Drawing Application/ Plan, Section and View Drawing

Video Code and Title	**Technical Criteria to be Checked**	**Status (Y/N)**	**Instructor Note / Score**
V7. Technical Drawing Application/ Plan, Section and View Drawing	Produce accurate floor plans		
	Apply visual hierarchy (lineweights, hatches)		
	Align drawings using auxiliary lines		

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
	Develop elevations and sections coherently		
	Ensure clarity and organization of the drawing		

1.5.4.2 V8. DWG – PDF, DXF – Import/Export Operations

This teaching material has been designed as a study guide to accompany "**V8. DWG – PDF, DXF – Import/Export Operations"**. This document serves as written support to facilitate the transition from technical drawing to the final production of professional drawings, following closely the structure of the lesson.

1. **Model Space vs. Paper Space**

Once the technical drawing in Model Space is completed, it is necessary to transfer the project to a professional presentation format. The distinction between these two working environments is fundamental to a proper workflow in AutoCAD. Therefore, it is essential to understand the difference between them:

- **Model Space:**
  This is the workspace where the drawing is created. It is an infinite working environment where objects are drawn at full scale (1:1). It is typically identified by a dark background (black or grey).

- **Paper Space (Layout):**
  This is the printing and layout environment where final drawings are composed. The project is not drawn here; instead, **viewports** are created to display the model. These act as "windows" into Model Space. It is identified by a white background, simulating a sheet of paper.

Note: Maintaining visually distinct background colors is considered good practice to immediately identify the active workspace.

2. Layout Management

To organize the different drawings within a project, layout tabs are used. At the bottom of the interface, multiple sheets can be managed. By right-clicking on a layout tab, access is provided to essential tools:

- **New Layout:** Creates a new drawing sheet from scratch.
- **Layout from Template:** Imports predefined sheet configurations.
- **Move or Copy:** Useful for reorganizing sheets or creating new layouts while maintaining the structure or title block of an existing one.
- **Delete / Rename:** Removes layout tabs or assigns new names to created sheets.
- **Paper Settings Management:** Allows customization of paper size and characteristics when not available in default templates.

3. Page Setup

Before arranging the layout, it is essential to define the physical characteristics of the drawing sheet. To ensure correct scale and size, the page setup must be properly configured. Key parameters include:

- **Printer/Plotter:**
  If no physical printer is available, it is standard practice to use PDF plotters (such as *AutoCAD PDF High Quality Print*), which improve vector and raster output resolution to ensure maximum print quality.
- **Paper Size:**
  Standard ISO formats are recommended. The selection depends on the scale and complexity of the project and should consider whether margins are included. For example:
  - **ISO A2:** Includes predefined margins.
  - **ISO A2 Expanded:** Reduces margins to increase drawing area.

- **ISO Full Bleed A2:** Borderless format, ideal for maximizing the printable surface.

- **Plot Scale:**
  In Paper Space, the plot scale must always be set to **1:1** (one unit in the layout equals one unit on paper, such as mm or inches). The actual drawing scale is defined within the viewports.

- **Plot Style Table (.ctb):**
  Custom or predefined plot styles may be used. These control how colors and lineweights are printed. The **Monochrome** style is the most commonly used in technical drawings, converting all colors to black with different grayscale intensities for proper visual hierarchy.

4. Creation and Control of Viewports

Viewports are frames that display Model Space content within Paper Space. To compose a drawing sheet, multiple viewports are placed and arranged as required.

Different types of viewports can be created depending on the intended use:

- **Rectangular:** Most commonly used for plans and elevations.
- **Polygonal:** Suitable for irregular view areas.
- **From Object:** Converts any closed shape into a viewport.

5. Scale and Display Management

Several basic concepts are necessary to efficiently work with viewports:

- **Access:**
  Double-click inside a viewport to enter Model Space within that window, and double-click outside (on the paper area) to return to Paper Space. Alternatively, a toggle in the status bar allows switching between spaces.

- **Scale Adjustment:**
  Once inside a viewport, the drawing can be framed using the mouse wheel or by

selecting a predefined scale from the status bar dropdown (e.g., assigning a viewport scale of 1:100).

- **Viewport Locking:**
  After setting the correct scale and framing, the viewport must be locked to prevent accidental zoom changes.

- **Layer Control per Viewport:**
  AutoCAD allows layers to be turned off within a specific viewport without affecting the global model or other viewports.

6. Layer Control and Visibility per Viewport

One of AutoCAD's most powerful features is the ability to control visibility independently for each viewport:

- **Freezing Layers in Current Viewport:**
  Layers (e.g., grids or annotations) can be disabled in a specific viewport, allowing cleaner representations without modifying the original model.

- **Lineweight Display:**
  The status bar includes an option to display lineweights on screen. Activating this is recommended to preview the printed result.

- **Viewport Layer:**
  Viewport frames should be placed on a non-printing layer. This ensures the content is visible while the viewport boundary is not displayed in the final output.

7. Annotations and Title Blocks

Paper Space is the appropriate environment to finalize the drawing presentation:

- **Title Block:**
  A predefined title block (adapted to the chosen format, e.g., A2) should be used to identify project information such as author, scale, and title.

- **Direct Annotations:**
  Texts and notes (e.g., "First Floor Plan") can be added directly in Paper Space,

maintaining consistent size regardless of viewport scale. These annotations are only visible in Paper Space.

8. Final Publishing and Exporting

Generated drawings can be exported or published in various formats. When no physical printer is available, PDF is the most suitable output format. Two main methods are used:

- **Single Plot:**
  From print preview, right-click and select *Print* to generate a PDF of the current sheet.
- **Batch Plot (Batch Publish):**
  This tool allows multiple layouts to be exported simultaneously into a single multi-page PDF document. It is especially useful when working with multiple prepared sheets.
  It is recommended to enable background publishing to continue working while files are generated.

Additionally, drawings can be exported to other formats via the AutoCAD application menu:

Format	Main Use
DWG	Native format for editing and collaboration
PDF	Standard for printing and universal viewing
DGN	Exchange with MicroStation and infrastructure systems
DXF	Universal exchange format for generic design and cutting software

9. Data Import

AutoCAD not only allows exporting data but also importing it. Formats such as PDF, DGN, or 3D files can be incorporated as references or base content for model creation.

Mastering AutoCAD 2D involves the ability to transform a complex drawing into a professional PDF document, properly organized by layers, accurately scaled, formatted according to standards, and ready for international distribution.

By mastering this workflow, optimal results can be achieved, turning a complex task into a manageable and efficient process.

9. Practical exercise.

Following the video instructions and using the attached file as your working document, create three plans of the building in paper space: two in A2 format and one in A3 format. These plans will then be printed as a single file. Use the attached PDFs as a guide

Files name: M2_8.1 Complete project

M2_V8.2 Exercise

M2_V8.3 PDF Printing project

10. Self-Assessment Checklist: V8. DWG – PDF, DXF – Import/Export Operations

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V8. DWG – PDF, DXF – Import/Export Operations	Manage Model Space and Paper Space workflow		
	Create and organize layouts		
	Configure page setup and plot settings		
	Use viewports with correct scale and locking		
	Export and import files (DWG, PDF, DXF) correctly		

1.6 Final Exam

Choose the correct answer (A, B, C or D). Only one answer is correct.

1. **Which element allows quick access to commands such as saving or undo?**
   A. Command line
   B. Status bar
   C. Quick Access Toolbar
   D. Layout tab
2. **What is the main purpose of Paper Space?**
   A. Drawing geometry at real size
   B. Editing objects
   C. Preparing drawings for printing
   D. Creating layers
3. **Which command is used to create a rectangle with defined dimensions?**
   A. LINE
   B. RECTANGLE
   C. POLYLINE
   D. ARC
4. **What is the function of Polar Tracking?**
   A. It helps draw at specific angles
   B. It removes geometry
   C. It creates circles
   D. It deletes commands
5. **Which command is used to remove unwanted parts of an object?**
   A. Offset
   B. Trim
   C. Copy
   D. Scale
6. **Why should different elements be placed on different layers?**
   A. To increase file size
   B. To reduce precision
   C. To avoid using commands
   D. To simplify drawing organization and control visibility
7. **What is the main purpose of adding dimensions to a drawing?**
   A. To decorate the drawing
   B. To improve color visualization
   C. To show real measurements
   D. To delete geometry
8. **What happens when you edit a block using the Block Editor?**
   A. All instances of the block update automatically
   B. Only one instance changes
   C. The block is deleted
   D. The drawing is closed
9. **What is the purpose of using auxiliary lines (XLINE)?**
   A. To apply dimensions
   B. To align elements accurately

C. To create hatches
D. To scale objects

10. **Which format is commonly used for printing and sharing drawings?**
A. DWG
B. DXF
C. PDF
D. DGN

Module 3

1. BIM for Design Phase (3D)

This is an application and curriculum guide for a 36-hour interdisciplinary BIM (Building Information Modelling) training designed to enable digital transformation in architecture and engineering curricula. This module aims to provide "information modelling" and "practical training" using BIM software across architectural, structural, and mechanical (MEP) disciplines based on the parametric working logic of Autodesk Revit software.

1.1 Objectives

Capacity Building: To increase the quality of digital architectural and engineering education and to enrich the curriculum infrastructure of modern design laboratories.

Transfer of BIM Standards: To convey Building Information Modelling terminology and workflows to participants on both theoretical and practical levels.

Multi-Disciplinary Collaboration Culture: To demonstrate how architectural, structural, and mechanical (MEP) disciplines can work coordinately on the same central model (Central Model) through a tangible project.

1.2 Learning Methodology

The training process is structured with a student-centered and project-based pedagogical approach. Instead of encountering complex systems from the first hour of training, students will construct an architectural project step-by-step, progressing from simple to complex.

Learning Outcomes:

1. Ability to effectively use the parametric working logic and interface components of Autodesk Revit software.
2. Ability to coordinate projects coming from different disciplines, manage links (altlık), and establish a coordinate system.
3. Ability to model detailed architectural structures, load-bearing systems (structural), and mechanical installation (HVAC/Plumbing) components.

1.3 Training Duration

The application described in this guide will be carried out through self-regulated learning via the BIM4WB platform.

This training is a total of 36 lecture hours.

1.4 Required Teaching Resources

Required Software: Autodesk Revit

1.5 Course Content

All the videos and supporting documents mentioned can be found in the following link: https://drive.google.com/drive/folders/1g1n1LbkkhHQGG-VV5_nf4NUMmAdxToAb?usp=sharing

3D modelling phase.

The technical scope, pedagogical objectives, and subheadings of the 9 application videos to be created within the scope of this module to ensure permanent learning for students are as follows:

1.5.1. V0. Software Interface

Description: This is the introductory video explaining the parametric object-based logic of Revit software. Interface elements, the Ribbon menu, the Properties panel, and the Project Browser structure are detailed.

Technical Subheadings: Application Menu, Quick Access Toolbar, View Windows (2D/3D), Selection Tools, Workspace Arrangement.

1.5.2 V1. Grid - Floor

Description: This covers the selection of templates to consider when starting a new architectural project and the construction of reference planes that form the skeleton of the project. Project units are configured.

Technical Subheadings: Project Units (UN), Creating Grid Systems (Grid - GR), Assigning Floor Plans and Levels (Level - LL), Architectural View Settings.

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score

V0. Software interface V1. Grid-floor	Correct parametric setup of Grids and Levels with appropriate names and intervals.		
	Accurate architectural selection of the project startup template.		

1.5.3 V2. Walls

Description: This examines the parametric structure of walls, which are one of the most fundamental system families in Revit. Layer thickness, material assignments, and structural functions (Core, Finish, Thermal/Air) of interior, exterior, and partition walls are taught.

Technical Subheadings: Wall Height/Depth, Location Line options (Wall Centerline, Core Face, etc.), Editing Wall Profile (Edit Profile), Curtain Wall Entry.

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V2. Walls	Correct definition of layer structures (Core, Finish, Thermal) for interior and exterior walls.		
	Appropriate selection of wall location lines (Location Line) based on project needs (e.g., Core Face).		

1.5.4 V3. Floor Settings – Columns

Description: This topic covers the placement and configuration of columns in Revit, focusing on their relationship with levels, grids, and floor elements. Users learn how to define column constraints, dimensions, materials, and attachment settings.

Technical Subheadings: Architectural vs. Structural Columns, Column Placement on Grids and Levels, Base/Top Constraints and Offsets, Column Rotation and Alignment, Attach Top/Base Options

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V3. Floor Settings – Columns	Correct selection of column type (Architectural or Structural).		
	Accurate definition of Base/Top Levels and offset values.		
	Proper alignment of columns with grids and floor layouts.		
	Appropriate attachment of columns to floors or other structural elements.		
	Consistent dimensions and material assignments across the project.		

1.5.5 V4. Curtain Wall

Description: This topic covers the creation and configuration of curtain walls in Revit. Users learn how to define curtain grids, mullions, and panel types, and how these components work together to create facade systems.

Technical Subheadings: Curtain Grid Layout, Curtain Panel Types, Grid Editing and Customization, Curtain Wall Properties and Constraints

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V4. Curtain Wall	Correct placement and spacing of curtain grids.		
	Proper alignment of curtain walls with building geometry.		
	Accurate customization of grids, panels, and mullions where required.		
	Consistent application of façade system settings throughout the project.		

1.5.6 V5. Wood–Ceramic Flooring

Description: This topic covers the creation and modification of wood and ceramic floor finishes in Revit. Users learn how to define floor layers, materials, thicknesses, and finish applications for different interior spaces.

Technical Subheadings: Floor Type Creation, Material Assignment, Layer Structure and Thickness, Floor Boundaries and Editing, Floor Finishes for Interior Spaces

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V5. Wood–Ceramic Flooring	Correct assignment of wood and ceramic materials.		
	Accurate definition of floor layer thicknesses.		
	Proper placement and boundary definition of floor elements.		
	Appropriate floor finish selection according to space function.		
	Consistent material and flooring settings throughout the project.		

1.5.7 V6. Door - Window

Description: It covers incorporating doors and windows that operate dependently on "Host" elements into the project, loading components from external family libraries (Revit Library), and modifying dimensional parameters.

Technical Subheadings: Load Family, Type Properties vs. Instance Properties distinction, Sill Height, Door Opening Directions, and Tagging.

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V6. Door - Window	Correct naming of doors and windows, and configuration of their width-height dimensions.		
	Suitability of sill heights and opening directions according to architectural rules.		

1.5.8 V7. Furnishing

Description: This topic covers the placement and management of furniture elements in Revit. Users learn how to insert, modify, and organize furnishing components while maintaining consistency with the architectural layout and project requirements.

Technical Subheadings: Furniture Families and Types, Furniture Placement and Alignment, Loading and Managing Families, Instance and Type Properties, Room-Based Furniture Layouts

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V7. Furnishing	Correct selection of furniture families and types.		
	Proper placement and alignment of furniture within spaces.		
	Accurate adjustment of instance and type parameters.		
	Consistency of furniture layouts with room functions and design intent.		
	Appropriate use and organization of furniture families throughout the project.		

1.5.9 V8. Adding Floors

Description: This topic covers the creation and modification of floor elements in Revit. Users learn how to define floor boundaries, assign floor types, and create floor systems that accurately reflect the architectural and structural design.

Technical Subheadings: Floor Creation Tools, Sketching Floor Boundaries, Floor Types and Properties, Editing Floor Shapes

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V8. Adding Floors	Correct creation of floor boundaries and sketch profiles.		
	Appropriate selection of floor types and materials.		
	Accurate placement of floors at the required levels.		

	Consistent floor settings and geometry throughout the project.		

1.5.10 V9. Roof

Description: This demonstrates how to model roofs, which form the upper enclosure of a building, based on different design geometries. Hip roof, gable roof, and flat terrace roof solutions are handled practically.

Technical Subheadings: Roof by Footprint, Roof by Extrusion, Assigning Slope (Define Slope), Attaching Walls to the Roof (Attach Top/Base).

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V9. Roof	Roof boundary lines forming a closed loop.		
	Turning off the 'Define Slope' setting on edges where a gable wall is intended, and successfully attaching walls to the roof.		

1.5.11 V10. Stairs - Railing

Description: This covers the parametric creation of staircases—one of the most complex components to model—according to regulatory criteria such as step height, number of risers, and width, alongside railing design.

Technical Subheadings: Stair by Component, Riser/Tread Calculator, Landing Layout, Defining Railing Path, and Profile Selection.

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V10. Stairs - Railing	Automatic calculation of the number of stair risers and treads relative to the floor height.		

	Railings accurately tracking the slope of the staircase host without errors.		

1.5.12 V11. Room – Room Seperator

Description: This unit video displays the functional schema of the architectural project, defines room boundaries, automatically executes net/gross area calculations, and visualizes them using color schemes.

Technical Subheadings: Room Tool, Room Separator, Room Tags, Creating Color Schemes, and Adding Color Legends for the Sheet Area.

Self-Assessment Checklist

Video Code and Title	**Technical Criteria to be Checked**	**Status (Y/N)**	**Instructor Note / Score**
V11. Room – Room Seperator	Definition and tagging of all enclosed volumes using the 'Room' tool.		
	Dividing open-plan spaces using 'Room Separator' and ensuring the Color Scheme is visible on the sheet.		

1.5.13 V12. Site Modeling

Description: This explains how to convert the topography where the structure will be built into a three-dimensional solid model within the Revit environment, using coordinated or contour-lined CAD files or point clouds.

Technical Subheadings: Toposurface/Toposolid, Point Placement, Generating Terrain via CAD Import, Opening a Building Pad, Placement of Trees and Environmental Components

Self-Assessment Checklist

Video Code and Title	**Technical Criteria to be Checked**	**Status (Y/N)**	**Instructor Note / Score**
V12. Site Modeling	Correct generation of the topography according to the elevation points in the CAD underlay.		

	Precise implementation of cut-fill planes (Building Pad) for the building footprint.		

1.5.14 Structural Modelling

Description: This phase involves building the structural load-bearing system behind the architectural model. The creation of analytical and physical models for reinforced concrete or steel load-bearing elements and the integration of foundation systems are demonstrated.

Technical Subheadings: Structural Column, Structural Beam Systems, Structural Slab, Foundations (Isolated, Wall, Slab Foundations).

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V13. From architecture to statics	Exact alignment and intersection of structural columns, beams, and foundations with architectural grids.		
V14. Axis-beam-curtain wall V15. Foundation	Flawless formation of analytical lines alongside the physical models of structural elements.		

1.5.15 Mechanical Modelling

Description: In the final technical phase of the course, the mechanical discipline designs of the building are addressed. Ventilation ducts (HVAC), air terminals, mechanical equipment, and clean/wastewater piping networks are modeled, completing the multi-disciplinary BIM cycle.

Technical Subheadings: Mechanical Equipment Placement, Duct Drawing and System Assignments, Pipe Modelling, Sloped Piping, Connector Settings, and Mechanical Detail Views.

Self-Assessment Checklist

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score

V16. From architecture to mechanics V17-18. Clean(hot-cold) water plumbing-1 V19. Waste water plumbing	Ensuring ventilation ducts and air terminals are connected to the system (Supply/Return) via connectors.		
	Applying required slopes in plumbing pipes according to the direction of flow.		

1.6. Exam

1. When a parameter of an element is changed via the "Type Properties" panel in Autodesk Revit, what kind of change occurs in the project?

    a) All elements belonging to that type in the project are simultaneously updated according to the new parameter.

    b) The change only affects the elements in the active floor plan; sections and 3D views do not change.

    c) Only the single object currently selected on the model screen is updated.

    d) Only the material and color properties of the element change; its geometric dimensions remain constant.

2. During the Revit architectural modelling process, what basic prerequisite is required to place components like doors and windows into the project?

    e) First, the relevant space must be defined using the 'Room' tool.

    f) The roof modelling of the project must be completed before placement can be done.

    g) The grids where the elements will be placed must be supported by structural columns.

    h) A "Host" element (such as a wall) that can accommodate the components must be present.

3. When is the “Location Line” setting selected as "Core Face: Exterior" during wall modelling, which layer is the reference line of the wall aligned with?

    a) It is aligned according to the exact geometric center axis of the wall structure.

    b) It is aligned according to the outer surface of the outermost plaster, insulation, or cladding layer of the wall.

    c) It is aligned according to the outer face boundary of the wall's main structural core layer (Core Boundary).

    d) It is aligned according to the core boundary facing the interior space side of the wall.

4. When designing a double-sloped (Gable) roof using the "Roof by Footprint" method, on which of the roof boundary lines should the "Define Slope" option be turned off?

    a) It should be turned off on all horizontal lines forming the eaves ends of the roof.

    b) It should be turned off on the vertical side lines where the gable wall of the roof is intended to be formed.

    c) It should be turned off only on reference lines that intersect with slope lines on the site.

    d) It should be turned off on the ridge line located at the center of the roof.

5. What do the terms "Riser" and "Tread" mean in the parametric settings of a staircase (Stair) element in Revit?

    a) Riser refers to the staircase railing height, while Tread refers to the distance between railing balusters.

    b) Riser refers to the reinforced concrete structural slab under the stairs, while Tread refers to the marble cladding of the step.

c) Riser refers to the total floor height of the staircase, while Tread refers to the total length of the stair run.

d) Riser refers to the step height, while Tread refers to the step width (the area stepped on).

6. Which tool should be used to define an open-plan area (e.g., Living Room and Dining Area) as two different "Rooms" and calculate their areas without constructing any physical partition walls in a floor plan?

    a) Invisible virtual wall openings should be created using the Wall Opening tool.

    b) Room Separator lines should be used.

    c) The plan view boundary should be restricted using the Scope Box tool.

    d) Separator lines should be drawn on the floor using the Model Line tool.

7. When modelling topography/terrain (Toposurface or Toposolid) in Revit, which method is followed to directly convert a DWG (AutoCAD) file containing 3D contour lines received from a survey engineer into a solid model?

    a) After referencing the file with 'Link CAD', the 'Create from Import' option within the site tool is used.

    b) The terrain is imported into the project like a piece of furniture using the 'Component' command under the Architecture tab.

    c) The CAD file is exploded to allow lines to convert into wall families.

    d) The coordinates of each curve in the CAD file are read, and 'Points' are placed manually on the plan view.

8. What is the most fundamental philosophical and technical difference between an architectural column (Architectural Column) and a structural column (Structural Column) in the Revit environment?

a) Architectural columns can only have a circular cross-section, while structural columns can only be rectangular or I-profiles.

b) Structural columns possess an 'Analytical Model' line for structural load analysis, whereas architectural columns only carry volumetric and visual cladding data.

c) Structural columns are only used in steel structures; the use of architectural columns is mandatory in reinforced concrete buildings.

d) Architectural columns are visible in floor plans, while structural columns are only listed in schedule tables.

9. In the structural modelling phase, which practical Revit function should be preferred to save time and ensure exact alignment when placing "Structural Foundation: Isolated" (Isolated Foundation) elements into the project?

a) Drawing foundations under architectural walls using the "Wall Foundation" command.

b) Clicking and placing each foundation element manually on the floor plan by estimation.

c) Automatically placing foundations under selected structural columns using the "At Columns" option.

d) Creating foundations in the architectural model first and then copying them to the structural model.

10. In the mechanical modelling (V9) phase, which built-in Revit tool should be used to graphically inspect open ends, unconnected elements, and incorrect flows in complex pipe (Pipe) and duct (Duct) networks?

a) The "Phase Filter" setting in the Properties panel.

b) The "Show Disconnections" panel under the Analyze tab.

c) The "Align" command under the Modify tab.

d) The "Render" engine under the View tab.

Module 4

1. BIM for Construction Phase (4D) and Cost Estimation (5D BIM)

This document presents an application and curriculum guide for a 4hrs theory and 10hrs training module entitled ***BIM for Construction Phase (4D) and Cost Estimation (5D BIM)***

Through this educational material, consisting of video tutorials and technical documentation, we will learn to transform a conceptual model into an advanced tool for site and budget management, ensuring that information evolves and grows alongside the project. In this block, we will address three fundamental pillars:

1. **4D Planning and Simulation (Temporal Control):**

We will explore time management from a conceptual perspective in Revit using project phases (Existing, Demolition, Temporary, and New Construction), which are essential for renovations and tracking construction milestones.

Navisworks TimeLine will be utilized to link the model to construction schedules (Gantt charts), allowing for the comparison of planned versus actual progress and the generation of visual simulations to optimize logistics and auxiliary means on-site.

2. **5D Cost Estimation (Economic Management):**

We will delve into precise quantity extraction through Revit Schedules, learning to calculate material take-offs and work units automatically.

We will examine professional integration with Presto via the Cost-it plugin, using Assembly Codes and Keynotes to connect model elements with price databases, thereby automating budget generation and the traceability of certifications.

3. **Model Quality and Constructability:**

Clash Detection Analysis will be performed in both Revit and Navisworks to identify critical interferences (such as duplicate masses or structural/MEP clashes) before they reach the construction phase.

A customized Quality Control Plan will be implemented using user-defined parameters and view filters (traffic light system), enabling rigorous visual monitoring of the execution status of every project element

1.1 Objectives

The objective of this block is for the student to achieve a level of technical maturity that allows them to lead the federated model coordination and ensure the technical and economic efficiency of any built asset

Through this educational material, three primary objectives are pursued:

4D Planning and Temporal Simulation: Mastering time control through the use of Revit phases to manage the project lifecycle, including existing, demolition, temporary, and new construction stages. Furthermore, the course aims to utilize Navisworks Timeline to link the model to construction schedules (Gantt charts), enabling visual simulations of work progress and the optimization of logistics and site auxiliary means.

5D Cost Management and Quantity Take-off: Achieving precision in quantity extraction via Revit Schedules, allowing for automated material and work unit takeoffs. The objective includes professional integration with Presto via the Cost-it plugin, using Assembly Codes and Keynotes to connect model elements with price databases and automate budget generation.

Quality Assurance and Constructability: Ensuring the model is technically and economically efficient through Clash Detection analysis in both Revit and Navisworks to identify interferences before execution. Additionally, the curriculum covers the implementation of a customized Quality Control Plan using user-defined parameters and view filters (traffic light system) to perform rigorous visual monitoring of every project element on-site

1.2 Learning Methodology

The methodology adopted in this module is based on an active, practice-oriented learning approach, following a learning-by-doing model widely used in vocational training. Each session combines instructor explanations with hands-on practice, allowing students to immediately apply the demonstrated concepts using the software.

Students develop their skills progressively, reinforcing their technical understanding and fostering independent problem-solving abilities. This approach is supported by written materials, enabling students to consolidate their knowledge and engage in self-directed learning.

Ultimately, the methodology aims to ensure the gradual acquisition of practical skills, fostering both technical proficiency and confidence in managing specialized software within the BIM model.

Learning Outcomes:

1. Understands the concept of analysis and the basic principles of performing analysis on a BIM model.
2. Explains how the BIM model is used for performance analysis and decision support in construction projects.
3. Recognizes different types of analysis such as energy, daylight, structural, cost, and time (4D/5D) analysis.
4. Understands the processes of integrating the BIM model with other software for analysis purposes.
5. Performs basic analysis on a real BIM model to detect and solve design or construction problems.
6. Applies clash detection methods and evaluates interdisciplinary model coordination.
7. Produces an integrated information model in collaboration with project stakeholders.
8. Reads and interprets data from interdisciplinary BIM models for construction planning.
9. Performs quantity take-off and cost estimation (5D) using BIM tools such as Revit.
10. Applies 4D simulation techniques to plan and visualize construction processes.

1.3 Training Duration

The application described in this guide will be carried out through self-regulated learning via the BIM4WB platform.

This training is a total of **4 theory + 10 hours** practice

1.4 Required Teaching Resources

Hardware requirements: computer lab equipped with computers with access to multimedia and the internet.

Software required: Revit (Autodesk), Navisworks (Autodesk), Presto (Rib Software) and Arquimedes (Cype)

1.5 Course Content

All the videos and supporting documents mentioned can be found in the following link: https://drive.google.com/drive/folders/1rovmCxjzvLzc-UKNXodSWoSLE0BW3Lj5?usp=sharing

1.5.1 Unit 1

1.5.1.1 V1. Analysis concept

1. First Visual Contact: The 3D View

The analysis always begins in a 3D view. If it is not visible in the Project Browser, it can be accessed directly through the *View > 3D Views* tab.

Objectives of the initial 3D analysis:

- Identify if the model includes only the building or also its environment.
- Verify the number of floors and the general volumetry.
- Understand the spatial relationship between different areas.

Using the Section Box:

For a deep analysis, longitudinal and transversal sections are created using the section box in the 3D view properties.

- **Element Morphology:** This allows you to see how elements like floors have been modelled (e.g., if the finish and the structure are independent elements).
- **Level of Detail (LOD):** You can observe how spaces, such as stairwells, communicate and the distribution of the building

2. Evaluating Maturity (Information and Organization)

A "mature" model contains organized data. This is reviewed in **the Project Browser:**

- **Sheets, Legends, and Schedules:** If these sections are empty, the model is likely in an early phase (between Preliminary and Basic Project).

- **Legends:** Contain information typically placed on the right side of sheets, such as floor types, descriptions, and construction details.
- **Schedules:** These are essential for counting elements and extracting model data.

- **Disciplines:** Review the organization of floor plans (finished floor), ceiling plans (lighting and false ceilings), and structural plans.
- **Systems (MEP):** By changing the discipline to "Plumbing" or "Electrical," you can check for modelled networks.
    - **Family Control:** It is vital to check if objects (toilets, sinks) have connectors (input/output nodes). If a fixture lacks connectors, it will not allow for the drawing of the installation.

3. View Management and Visibility Graphics

To analyse specific parts (like the structure), it is recommended to duplicate the 3D view and apply filters.

Methods to isolate information:

- **Hide Elements/Categories:** By right-clicking an object. Hiding a *category* is equivalent to turning off a whole layer (e.g., all windows).
- **Visibility/Graphic Overrides (Command VV or VG):** Manages layers for Model Categories (construction elements), Annotation Categories (text, dimensions), and Analytical Model Categories (for structural analysis).
- **Reveal Hidden Elements:** Using the **lightbulb** icon in the bottom bar. Hidden elements will appear in a bright magenta/pink colour.

4. Information Extraction: Schedules

Schedules are the direct connection to the **Revit database**.

Creating a Quantity Schedule:

- **Select Category:** For example, "Structural Columns".

- **Add Fields (Parameters):** Select data such as Type, Base Level, Count, Volume, or Cost.
- **Filters:** These allow you to exclude elements that do not meet certain criteria (e.g., showing only columns of a specific section).
- **Sorting and Grouping:**
    - Allows for ordering by levels or types to give the table coherence.
    - **Headers and Footers:** Used to separate groups and view subtotals.
    - **Itemize every instance:** If unchecked, Revit groups all identical elements into a single row, showing the total count.
- **Formatting:** It is essential to check the **"Calculate totals"** box for desired columns (like Volume or Count) so the program performs the sums in the footer or Grand Total.

5. Practical exercise.

Using the provided Revit building model, analyse the model and use the tools learned as shown in the lesson video.

File name: M4_V1 Revit ARCH

6. Self-Assessment Checklist: V1. Analysis concept

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V1. Analysis concept	Access and navigate 3D views to identify building volumetry, number of floors, and environment.		
	Correctly use the Section Box to analyse internal morphology (e.g., floor layers) and vertical communications.		
	Identify geometric errors such as "flashing/glitches" (double counts), overlaps, and undefined elements.		

	Assess model maturity by checking for the existence of Sheets, Legends, and Schedules in the Project Browser.		
	Navigate different disciplines (Architectural, Structural, MEP) and verify if objects have the necessary connectors.		
	Manage visibility using Visibility/Graphic Overrides (VV/VG) and isolating/hiding specific categories.		
	Use the "Reveal Hidden Elements" tool (lightbulb icon) to manage and restore hidden objects.		
	Create Schedules by selecting specific categories and adding relevant data fields (Parameters).		
	Apply Filters to schedules to focus on specific element types or conditions.		
	Use Sorting and Grouping to organize data with headers, footers, and blank lines.		
	Configure formatting to "Calculate totals" and choose between "Itemize every instance" or grouped summaries.		

1.5.1.2 V2. Building Information Modeling for Construction Sites

This teaching material has been designed as a study guide to accompany "**V2. Building Information Modeling for Construction Sites".** Its objective is to serve as written support, following the same structure as the lesson.

1. Evolution of the BIM Model

The goal of using BIM in this phase is for the building to evolve from basic levels (preliminary design or basic project) to the execution project, its use on the construction site, and finally As-Built documentation for asset management.

2. Managing Sections and Facade Details

To document correctly, the workflow moves from global sections to detailed ones:

- **Strategic Placement:** It is recommended to generate sections at specific locations (such as the second floor) to identify critical points like carpentries and facade junctions.
- **Segmented Sections ("Z" Icon):** Revit allows a section to be divided into several segments using the small "Z" icons.
    - This allows the removal of repetitive parts (like typical floors) to create a compact typical facade detail by merging the relevant parts (floor slab, window, upper slab).
    - Segments can be reunited by dragging the control nodes until they merge again.

3. Geometric Refinement and Quality Control

Before documenting, modeling errors detected in the sections must be corrected:

- **Join Geometry:** This tool is used to resolve "double counting" or material overlaps (e.g., when a slab and a wall occupy the same space). By joining geometry, the model gains precision and measurements become real.

4. Intelligent Annotation and Tagging

Documentation relies on tags that extract information directly from the model's database:

- **Annotation Crop:** A frame that limits the visibility of text and tags; anything outside this frame disappears to prevent reading errors on the sheet.
- **Material Tags:** These automatically identify the layers and materials defined in the properties of the wall or element.
- **Customizing Tags (Mark vs. Description):**
    - The tag family can be edited to display the "Mark" (a code or number) instead of the text description.
    - This is useful for very dense details where long text would hinder legibility; the numbers (01, 02, etc.) are then associated with a legend or table.

5. Material Take-off Schedules

Unlike regular object schedules, material take-offs have a different taxonomy and allow for extracting exact quantities of every component:

- **Multi-category:** Allows listing materials from different families (doors, walls, floors) in a single table.
- **Configuration:** It is essential to add fields such as *Material Name*, *Mark*, *Area*, and *Volume*.
- **Calculating Totals**: In the formatting tab, "Calculate totals" must be activated for volume or area columns to obtain the sum and avoid the "varies" message.

6. Creating High-Precision Construction Details

There are two main methods for generating large-scale details (1:5, 1:10, 1:20):

A. Callouts

These are sections within other sections that function as a "zoom".

- They allow for adding 2D information that is not modelled in 3D to avoid overloading the model, such as:
    - **Detail Lines:** To draw waterproofing membranes or small profiles.
    - **Masking and Filled Regions:** To represent drips, seals, or insulation with specific textures.
    - **2D Components:** Pre-drawn objects like bricks, bolts, or anchors.
- **Visualization:** The Revit model can be set to "Halftone" (gray) to differentiate the 3D model from the 2D technical drawing added by the designer.

B. Legends

These allow for creating details independent of the 3D model.

- They are ideal for importing AutoCAD files or drawing details that do not need to be synchronized with the physical model.

- ***Warning:*** Alterations in legends or manual 2D elements are not synchronized with the 3D model; if the model changes, the manual detail must be updated separately.

7. Advanced Applications on the Construction Site

Using material take-offs allows for proactive construction management:

- **Supply Negotiation:** Knowing the total volume of concrete (e.g., 585 m^3) from the start allows for closing fixed-price and supply contracts, avoiding market variations.
- **Environmental Impact:** A column for the ecological footprint can be added for each m^3 of material to obtain the total environmental impact of the building.
- **Waste Management:** It allows for estimating the percentage of waste (1%, 2%, etc.) generated by each material batch to comply with environmental controls on site.

8. Practical exercise.

Using the provided Revit building model, analyse the model and use the tools learned as shown in the lesson video.

File name: M4_V2 Revit ARCH

9. Self-Assessment Checklist: V2. Building Information Modeling for Construction Sites

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V2. BIM for Construction Sites	Create and manage segmented sections using the "Z" icon to remove repetitive floors and focus on typical details		
	Resolve geometric overlaps and "double counts" by using the Join Geometry tool to ensure precise measurements,		
	Apply and adjust the Annotation Crop frame to manage the visibility and layout of technical notes on sheets		
	Use Material Tags to identify components and customize them to show		

	either full descriptions or specific Marks (codes)		
	Generate Multi-category Material Take-off schedules including fields for Name, Mark, Area, and Volume		
	Configure schedule formatting to "Calculate totals" for quantities like concrete volume to support site supply negotiations		
	Create Callouts (sections within sections) to develop high-scale construction details		
	Add 2D information to details, such as detail lines, masking regions (for drips), and 2D components		
	Use the Halftone (Hatching) visualization setting to distinguish original 3D model elements from manually added 2D details.		
	Create Legends for independent details or CAD imports that do not need to be synchronized with the 3D model		
	Utilize material data to estimate environmental impacts (carbon footprint) and waste management percentages		

9.5.1.1 V3. Model integration and management

This teaching material has been designed as a study guide to accompany **"V3. Model integration and management"** Its objective is to serve as written support, following the same structure as the lesson.

The BIM system is designed for teamwork, allowing multiple specialists to work simultaneously on the same project without the need to close files to make way for one another.

1. Fundamentals of Collaborative Work (Work-sharing)

Collaborative work allows one user to handle walls, another to handle schedules, and another to handle site work at the same time.

- **Ownership and Requests:** When a user places an element (e.g., a wall), it becomes their "property" and responsibility. If another user wants to modify it, they must send an **editing request**, which appears as a pop-up window in the owner's model.
- **Work sets (Subprojects):** These function as "ownership cards" to organize work by specific areas or categories.
- **The Central Model (Server):** Because Windows typically only allows a file to be opened by one program at a time, a "server file" is used as an intermediary. Local instances created by users connect to this server to edit the file.
- **Synchronization:** This is the manual process of sending changes made in the local model and receiving updates from the central model.

2. Inter-Disciplinary Oversight and Supervision

Oversight is used to track what happens to specific elements when different specialists (e.g., architecture and structure) are involved.

- **Change Notifications:** If an architect moves a ventilation grille or a pillar for design reasons, the person in charge of systems (MEP) or structures receives an automatic notification to adjust their model (e.g., moving pipes or reinforcements).
- **Federated Model:** The final goal is to link various files (architectural, structural, MEP) to verify they match and do not present spatial conflicts.

3. Quality Control: Clash Detection

This process seeks design errors to ensure the model is theoretically buildable before reaching the construction site.

Types of Analysis:

1. **Between different models:** Comparing the architectural model against the structural model (e.g., columns vs. columns).
2. **Within the same model:** Detecting conflicts between categories (e.g., walls vs. beams or floors vs. structural columns).

Resolution Procedure:

- When running the check, the program generates a fault report.
- The "Show" option is used to locate the exact element in a 3D view.
- Many errors are resolved using the "Join Geometry" tool (e.g., joining a wall with a beam or a floor slab).
- Benefit: By clearing these errors, accurate measurements (m^2) are obtained, and material duplications that should not be counted are eliminated.

4. Coordinated Workflow: The "Datum" Method

Project organization depends on scale and complexity, but a standard coordinated workflow is often divided into three main files:

1. **Datum File (Site/Location):** Contains starting data, such as levels and grids (axes), that coordinate the entire project.
2. **Architectural File:** A basic discipline that pulls data from the Datum.
3. **Structural File:** Links to both the Datum and Architecture to make technical decisions.

5. Copy/Monitor Tool

This function allows for the "oversight" of elements from a linked file.

- **The "Electrocardiogram":** When monitoring a level or a grid, the element displays an icon similar to an electric pulse. This indicates Revit is monitoring in real-time what happens to that element in the source file.
- **Systems Use:** Lighting fixtures or plumbing fixtures can also be monitored so that if the architect moves them, the engineer is notified.

6. Coordination Review for Changes

When the person responsible for the Datum file makes a substantial change (e.g., raising all levels by 1 meter), other agents receive a message when opening their projects: "Instance requires coordination review".

Action Options: Upon detecting a change, the user can:

- **Postpone:** Leave the decision for later.
- **Reject:** If the change is incompatible with their discipline or urban regulations.
- **Move to Datum level:** The program automatically adjusts the local element to match the new data in the master file. If walls are connected to levels, the building will "grow" or adjust automatically.

7. **Practical exercise.**

Using the provided building models in Revit format, analyse the model and apply the tools you have learned, as demonstrated in the lesson video. Try to complete all the tasks presented in the video to maximize your learning.

Files name:

M4_V3 Revit ARCH

M4_V3 Revit STR

Self-Assessment Checklist: V3. Model Integration and Management

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V3. Model Integration and Management	Understand Work-sharing fundamentals: simultaneous editing, element ownership, and managing Editing Requests.		
	Distinguish between the Central Model (Server) and local instances, and perform a manual Synchronization.		
	Organize project elements and ownership using Work sets (Subprojects).		
	Create a Federated Model by linking external Revit files (e.g., Architecture and Structure).		
	Execute Clash Detection to find interferences between different models or within categories of the same model.		

	Resolve geometric conflicts using the "Show" tool and "Join Geometry" to ensure accurate measurements.		
	Set up a coordinated workflow using a Datum (Site) file containing master Levels and Grids.		
	Use the Copy/Monitor tool to track changes in linked files (identifying the "electrocardiogram" monitoring icon).		
	Manage Coordination Review alerts by choosing to Postpone, Reject, or Move to Datum level.		
	Clean up model "burrs" (overlaps) to eliminate material duplications in take-off schedules.		

9.5.2 Unit 2

9.5.2.1 V4. Clash Analysis

This teaching material has been designed as a study guide to accompany **"V4 Clash Analysis".** Its objective is to serve as written support, following the same structure as the lesson.

1. Introduction to Clash Analysis

The main objective of Clash Analysis is to detect interferences in a federated model to eliminate theoretical failures and refine the design until a perfect model is achieved before construction.

For this process, Navisworks is used, which has two main versions:

- **Navisworks Freedom:** A free model viewer.
- **Navisworks Manage:** The complete manager that allows for collision analysis.

File Formats

Navisworks acts as a "glue" that brings together work from various software (Revit, Archicad, Cype, CAD). When loading Revit files (.RVT), Navisworks generates its own working files, primarily cache and result files such as .NWC and .NWD.

2. Setting Up the Workspace

The Navisworks interface allows for customizing the workspace to access necessary tools:

- **Activating Tabs:** From the View > Windows tab, you can activate panels such as the selection tree, properties, and saved viewpoints.
- **Workspaces:** You can load predefined configurations; the "Extended" mode is the one that has almost all tabs activated by default.
- **Properties and Views:** When selecting objects, all their properties are visible (even if they come from IFC formats). You can also create Saved Viewpoints to generate photos, organize them into folders, and add comments for review.

3. Preparation: Selection Sets

Before running clashes, it is essential to organize the model using Sets. These are "packages of things" grouped by criteria (e.g., "first-floor pillars") that facilitate quick selection for specific tests.

4. Configuring the Clash Detective

To start the analysis, activate the Clash Detective tab from the View menu.

Step 1: Add Test

A new test is created, which functions like a database (similar to an Excel sheet) where errors, status updates, and results will accumulate.

Step 2: Define Rules

Rules allow you to tell the program what to ignore to avoid false positives, such as:

- Items on the same layer.
- Items in the same group or block.
- Items within the same file.

Step 3: Selection

Choose the models or parts of the model to be compared. You can compare an entire file against itself or look for specific elements by level or category.

Step 4: Test Types

There are different types of analysis based on the project's needs:

1. **Hard:** Detects elements that physically touch or intersect. A common tolerance mentioned is 1 mm.
2. **Clearance:** Detects elements that do not meet a minimum safety distance (e.g., ensuring water and electricity lines are at least 30 cm apart, or maintaining a 1.5 m radius in front of doors for accessibility).
3. **Duplicates:** Locates elements that have been modelled twice in the same location.
4. Management and Evaluation of Results

Once the test is run (Run Test), the software lists the found conflicts.

Conflict Statuses. Each error can pass through different management states:

- **New:** Recently detected conflict.
- **Active:** Currently being managed.
- **Reviewed:** Has already been observed.
- **Approved:** A supervisor (e.g., the BIM coordinator) validates that the conflict is acceptable. The person responsible for the approval is recorded.
- **Resolved:** The error has been corrected in the source model.

Organizing Errors

Conflicts can be grouped into packages by nature (e.g., structures, MEP) to assign specific responsibilities, such as to the architect or engineer, allowing for detailed notes and descriptions regarding the collision.

5. Resolving Conflicts in Source Software (Revit)

Many errors detected in Navisworks are often warnings that already appear in Revit.

- **Linkage Errors:** These occur when a wall is attached to a floor; if the floor changes or the wall geometry extends beyond the floor's contact area, it generates a link error.
- **Double Counting:** It is vital to resolve conflicts where two elements occupy the same space (e.g., a beam passing through a wall), as this results in double counting mass and incorrect budget measurements.

6. Generating Reports

The final step is to communicate the errors to the modelers for correction.

- **Recommended Format:** The HTML format is ideal because it opens as a webpage and requires no special software to view.
- **Report Content:** It includes images of each conflict, the IDs of the elements involved, affected levels, comments, and assigned personnel.

7. Strategies for Efficient Analysis

To avoid being overwhelmed by thousands of errors, it is recommended to:

1. **Analyse by Floor:** It is simpler to resolve problems locally floor by floor (e.g., walls on floor 1 against floors on floor 2).
2. **Use Section Boxes:** In Revit, using section boxes allows for a "tomography" of the building to visually detect and fix conflicts quickly.
3. **Join Geometry:** Using the "Join Geometry" tool during modelling helps elements "die" where they should, preventing unnecessary interference.

8. Practical exercise.

Using the provided building models in Revit format, analyse the model and apply the tools you have learned, as demonstrated in the lesson video. Try to complete all the tasks presented in the video to maximize your learning.

Files name: M4_V4 Revit ARCH

M4_V4 Revit STR

M4_V4 Revit PLUMBING

9. Self-Assessment Checklist: V4. Clash Analysis

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V4. Clash Analysis	Distinguish between Navisworks Freedom (viewer) and Navisworks Manage (manager).		
	Identify and manage file formats: .RVT (source), .NWC (cache), and .NWD (results).		
	Configure the workspace using the "Extended" preset and activate panels (Selection Tree, Properties, Saved Viewpoints)		
	Navigate the federated model using orbit tools and selection methods similar to Revit.		
	Create and organize Selection Sets (packages of items) based on criteria like level or category.		
	Initialize a test in Clash Detective and define Rules to ignore irrelevant conflicts (e.g., same layer or file)		
	Execute and differentiate between test types: Hard (Static), Clearance (minimum safety distance), and Duplicates.		
	Manage conflict Statuses (New, Active, Reviewed, Approved, Resolved) and assign responsibility to team members.		
	Group conflicts by nature (e.g., Structural vs. MEP) and add detailed descriptive notes.		
	Generate an HTML report including images, element IDs, levels, and assigned personnel		

9.5.2.2 V5. Problem detection and solving

This teaching material has been designed as a study guide to accompany **"V5 Problem detection and solving"** Its objective is to serve as written support, following the same structure as the lesson.

This didactic guide details the procedure for creating a Quality Control Plan in BIM, based on ISO 9001 standards, to ensure the traceability of all incidents and repairs during the construction execution phase.

1. Introduction: From Detection to Resolution

Before starting the quality plan, it is essential to resolve errors detected in previous phases (such as clash detection).

- **Action:** The model must be accessed and the heights, positions, and interferences of the elements presenting conflicts must be manually corrected.
- **Purpose:** Once the model has been cleaned, the next step is to create a transversal system that allows managing parameters, schedules, and specific views for construction control.

2. Definition of the Workflow (The 4 Stages)

The system is based on four states through which any element with an issue pass (doors that scrape, wall impacts, poorly adjusted windows, etc.):

- **CC0 - Initial Inspection:** The technician identifies a problem on site and documents it.
- **CC1 - Repair Phase:** The contractor or worker receives the notice, carries out the repair, and records it.
- **CC2 - Re-inspection and Validation:** The technician revisits the site to confirm whether the repair is correct.
- **CC3 - Final Approval:** The element is marked as compliant and the quality cycle is closed.

Note: It is recommended to create a legend in the project explaining this workflow through texts and diagrams so that anyone opening the model understands the procedure.

3. Technical Implementation: Project Parameters

To manage this data in Revit, it is necessary to create Project Parameters that act as information fields associated with objects.

Parameter Configuration:

- **Parameter type:** They must be Instance parameters, since the issue affects an individual object (a specific door) and not the entire family type.
- **Grouping:** It is recommended to group them under the "Construction" heading to easily locate them in the properties panel.
- **Affected categories:** In this exercise they are applied to walls, doors, and windows.

Data Structure by Phase:

- **Checks (Yes/No):** To mark whether the phase has been completed (CC0_Check, CC1_Check, etc.).
- **Dates (Text):** To document when each event occurred.
- **Observations (Text):** To detail the problem or the applied solution (e.g., "door scrapes when opening").

4. Information Management through Schedules

Once the parameters are created and some issues are documented in the model, management is carried out massively through Multi-Category Schedules.

- **Creation:** Fields such as Category, Level, and all the created quality parameters (CC0 to CC3) are included.
- **Filtering:** The schedule can be filtered so that it only shows elements with the first check (CC0) marked, that is, only the objects that have entered quality control.
- **Use:** From the schedule, observations can be written or phase steps marked, which automatically updates the information in the 3D object and vice versa.

5. Visual Control: The Traffic Light System

To understand the state of the construction "at a glance," View Filters are configured to colour the elements according to their quality status.

Filter Configuration (Colour logic):

- **Red (CC0):** Inspected element with an error (Check 0 active, but the others not).
- **Orange (CC1):** Element in the resolution phase by the contractor.
- **Green (CC2):** Repaired element pending final validation.
- **Blue (CC3):** The "perfect" one. Element approved at first instance or after the repair cycle.

This system allows the technician, when opening a 3D view or a floor plan, to instantly visualize which areas of the construction require immediate attention.

6. Advanced Applications and Conclusion

This parameter system is fully flexible and extensible to other construction needs:

- **Full traceability:** Parameters can be created for concrete control (pouring date, truck registration, batch number, test samples).
- **External documentation:** It is possible to create URL-type parameters that directly link to PDFs of certificates, emails, or delivery notes stored in the cloud (e.g., Google Drive).
- **Customization:** It allows managing client choices (paint colours, tile types) without doubts about what must be executed.

The objective is that you must be able to transform the model into a dynamic database that allows rigorous, historical, and visual monitoring of building quality.

7. Practical exercise.

Using the provided building models in Revit format, analyse the model and apply the tools you have learned, as demonstrated in the lesson video. Try to complete all the tasks presented in the video to maximize your learning.

8. Self-Assessment Checklist: V5. Problem detection and solving

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V5. Problem detection and solving	Have I manually corrected the errors and clashes identified in previous analysis (e.g., Navisworks or Revit Interference Check) before starting the quality plan?		
	Have I created a Project Legend explaining the Quality Monitoring Plan, including texts and schemas that define the operational flow?		
	Do I understand and can I define the 4-stage lifecycle of an issue: CC0 (Inspection), CC1 (Repair), CC2 (Re-inspection/Validation), and CC3 (Final Approval)?		
	Can I create Project Parameters (Instance type) grouped under "Construction" for Checks (Yes/No), Dates (Text), and Observations (Text)?		
	Have I correctly assigned the quality parameters to the relevant categories (Walls, Doors, and Windows) within the Project Parameters menu?		
	Have I developed a Multicategory Schedule that includes all quality parameters to manage data centrally across different families?		
	Can I apply filters to the schedule to isolate only the elements currently undergoing quality control (e.g., filtering by CC0 Check)?		
	Am I able to create View Filters in the Visibility/Graphics menu to automatically colour-code elements based on their status?		
	Can I set up complex rules (e.g., CC0 is Yes AND CC1 is No) to ensure elements		

	display the correct phase colour (Red, Orange, Green, or Blue)?		
	Can I document specific field issues (e.g., "scratched door," "misaligned window") and verify that the 3D model updates its colour status automatically?		
	Do I know how to create URL parameters to link model elements directly to external documentation like PDF certificates or delivery notes on Google Drive?		

9.5.3 Unit 3.

9.5.3.1 V6. Planning and 4D simulation.

This teaching material has been designed as a study guide to accompany **"V6 Planning and 4D simulation"** Its objective is to serve as written support, following the same structure as the lesson.

This technical and didactic guide details the processes for carrying out planning and time simulation (4D BIM) using Navisworks and Revit.

The 4D dimension of BIM integrates the time factor into the three-dimensional model, allowing the visualization of the construction process, the management of milestones, and the analysis of the life cycle of an asset.

PART 1: Dynamic Simulation with Navisworks Timeliner

Navisworks allows linking model elements to a schedule in order to generate visual simulations of construction progress.

1.1 Preparation and Model Loading

- **.NWC files:** When loading a Revit model into Navisworks, the program automatically generates a cache file (.nwc), which is its own format for classifying families and managing data.
- **Selection Tree:** It is used to navigate through the model and select groups of elements (e.g., columns of level 0, floors) that will be built at the same time.

1.2 Timeliner Setup (Gantt Chart)

The Timeliner tool essentially works as a Gantt chart where construction tasks are defined.

- **Task creation:** Tasks are added manually (e.g., “Columns Level 2”) and can be organized hierarchically or moved according to the logical order of construction.
- **Linking elements:** By right-clicking on the task, the option “Link current selection” is used to connect the selected objects in the model with their corresponding task in the schedule.
- **Task types:** It is essential to assign a type (e.g., Construction or Demolition) so that objects appear or disappear during the simulation with the appropriate graphics.

1.3 Comparison: Planned vs. Actual

The program includes columns for Planned Start/Finish (theoretical) and Actual Start/Finish.

- **Time deviations:** By entering actual dates, the program generates comparison bars that allow visualizing delays or advances, facilitating logistical decision-making (such as crane movement or material storage).

1.4 Simulation and Video Export

- **Configuration:** The colours of the states can be customized (e.g., green for elements under construction and blue for temporary elements).
- **Export:** The simulation can be exported as an animation in AVI format. The use of standard codecs and configuring frames per second (e.g., 24 fps) is recommended for smooth visualization.

PART 2: Lifecycle Management and Phases in Revit

Unlike task-based simulation in Navisworks, Revit uses a conceptual approach based on temporal milestones or intervention phases.

2.1 The Concept of Phases

Revit manages time through specific moments called phases (e.g., Existing, New Construction, Renovation 2026).

This allows “teleporting” in time to see the building at different stages.

2.2 The 4 States of an Object

Every element in Revit is created and demolished at a point in the database. This generates four possible states:

- **Existing:** Elements created in previous phases that remain in the project.
- **Demolished:** Elements that were created before but are removed in the current phase (using the Hammer/Demolish tool).
- **Temporary:** Objects that are created and demolished within the same phase (e.g., scaffolding or construction cranes).
- **New:** Elements created in the current phase that continue into the future.

2.3 Phase Filters and Graphic Overrides

To control what is seen and how it is displayed in each drawing, Phase Filters are configured:

- **Current state:** Shows only existing elements.
- **Demolitions:** Shows existing elements and highlights what will be demolished.
- **Post-demolition state:** Hides what has already been removed.
- **Final state:** Shows the existing elements plus the new ones.

Standard colour code (modified):

- **Red:** Demolished elements
- **Gray:** Existing elements
- **Yellow/Black:** New elements
- **Blue:** Temporary elements

2.4 Visualization and Project Evolution

The most powerful aspect of this system is that it allows duplicating views and assigning them different filters to document the evolution of the project immediately. “Before and after” images or drawings can be generated simply by changing the phase filter in the view, ensuring full traceability of all model assets.

3. Practical exercise.

Using the provided building model in Revit format, apply the tools you have learned, as demonstrated in the lesson video. Try to complete all the tasks presented in the video to maximize your learning.

File name: M4_V6 Revit ARCH

4. Self-Assessment Checklist: V6 Planning and 4D simulation

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V6.1: 4D Planning and Simulation in Navisworks	Do I understand that loading a Revit file into Navisworks generates an NWC cache file for data management?		
	Can I use the Selection Tree to isolate specific construction packages (e.g., Level 0 columns vs. Level 1 slabs)?		
	Am I able to create, order, and group tasks within the Timeliner to build a functional Gantt chart?		
	Can I link model elements to tasks using the "Attach Current Selection" tool?		
	Do I know how to enter and compare "Planned" vs. "Actual" dates to identify construction delays?		
	Have I assigned the correct Task Type (e.g., Construct or Demolish) to ensure elements appear or disappear during simulation?		
	Can I use the simulation to analyze the movement of temporary assets like cranes, site offices, and stockpiles?		
	Am I able to export the simulation as an AVI video, configuring the Microsoft codec and 24 FPS for a smooth output?		
V6.2: 4D Life Cycle Management and Phases in Revit	Can I set up filters to show specific states (e.g., "Existing + Demolished") using "Overridden" or "By Category" settings?		

	Have I configured the standard color codes (Red for demolished, Yellow for new, Blue for temporary, Gray for existing)?		
	Do I know how to model a Temporary object that is created and demolished within the same phase (e.g., scaffolding)?		
	Can I duplicate views and use different phase filters to document the "Before and After" stages of a renovation?		
	Can I create and manage custom Project Phases (e.g., Existing, 2026 Renovation) to represent different project milestones?		
	Do I understand the four states of an object: Existing, Demolished, New, and Temporary?		
	Am I proficient in using the Hammer tool to assign the "Phase Demolished" parameter to specific elements?		

9.5.4 Unit 4.

9.5.4.1 V7.5D Construction Planning

This teaching material has been designed as a study guide to accompany **"V7. 5D Construction Planning"** Its objective is to serve as written support, following the same structure as the lesson.

This document presents a technical and didactic guide on construction planning and cost estimation (5D BIM), based entirely on the provided sources. The content is organized to guide the user from basic modelling concepts to professional export to measurement software.

The integration of costs into a BIM model makes it possible to transform a geometric representation into a dynamic economic database. To achieve this, there are mainly two working approaches: generating measurements within the Revit model itself or using specific measurement software (such as "Presto" or "Arquímedes") through plugins or "translators".

1. Modeling Foundations for Measurements (Maturity)

For a budget to be accurate, the model must have an appropriate level of maturity.

- **Layered modelling:** In basic models, a wall may have several layers within a single element. However, for professional measurement extraction, it is recommended to generate each layer as an independent wall (e.g., one wall for brick, another for plaster). This allows assigning a specific price to each material and work unit.
- **Key type parameters:** Each element must contain three fundamental data points in its "Edit Type" section to generate the budget:
    - **Description:** Technical detail of the material or work unit (e.g., "m² of laid brick...").
    - **Type mark:** It works as the element's "registration number", linking it to the code of a construction price database.
    - Cost: The unit price of the element or material.

2. Creation of Schedules in Revit

The process to create an internal budget in Revit follows a logical configuration path:

- **Creating the schedule:** The category to be measured is selected (e.g., Doors or Windows) and the project phase is defined (e.g., New Construction).
- **Field selection:** Parameters such as Family, Type, Description, Count, and Cost are added.
- **Total Cost Calculation:** The "Add calculated parameter" (fx) function is used. It is defined as type "Currency" and a formula is created to obtain the total cost per typology.
- **Sorting and Grouping:**
    - It is sorted by Family and Type.
    - The option "Itemize every instance" is unchecked to group all identical elements into a single operational row.
- **Formatting and Totals:**
    - In the "Formatting" tab, "Calculate totals" must be enabled for the Count and Total Cost columns.

- Units can be configured to display the euro symbol (€) and right alignment for greater clarity.

3. Certification and Visual Quality Control

The BIM model allows financial control beyond the initial budget:

- **Certification parameters:** A project parameter called "Certification" (number type) can be created.
  By assigning a number (e.g., Certification 1, 2, 3) to each element, it is possible to filter schedules to issue partial invoices according to construction progress.
- **Visual control (traffic lights):** Through view filters, elements can be coloured differently according to their certification status, allowing visualization in 3D of which elements have already been invoiced.

4. Auditing through Multi-Category Schedules

To ensure that no element is left without a price, it is recommended to create a multi-category schedule.

- This schedule works as a global quality control, showing all families and types in the project.
- It allows quickly identifying which elements lack a description or "registration number" (code), enabling the data to be completed directly in the schedule so that the budget updates automatically.

5. Integration with External Software (Arquímedes and Presto)

When a higher level of specialization is required, external add-ons are used:

- **Cost-it:** Acts as the translator to transfer information from Revit to Presto.
- **Arquímedes (CYPE):** Allows generating a measurement extraction file (MCSV). This file exports all general information: categories (walls, beams, sanitary fixtures, etc.), materials, dimensions (length, height, net width), and groups.

- **Dual workflow:** The advantage of these programs is that they allow working with linked models. When a measurement line is selected in the budgeting program, Revit automatically highlights the corresponding element, ensuring full traceability between the measurement and the 3D model.

6. Practical exercise.

Using the provided building model in Revit format, apply the tools you have learned, as demonstrated in the lesson video. Try to complete all the tasks presented in the video to maximize your learning.

File name: M4_V7 Revit ARCH

7. Self-Assessment Checklist: V7. 5D Construction Planning

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V7. 5D Construction Planning	Can I distinguish between generating measurements internally in Revit and using external "translators" like Cost-it (for Presto) or Arquímedes?		
	Do I understand that for professional 5D estimation, each material layer should be modelled as an independent wall to assign specific prices to each unit of work?		
	Have I correctly filled the Description, Type Mark (as a price database "license plate"), and Cost fields within the element's Type Properties?		
	Can I create a new Schedule for specific categories (e.g., Doors or Windows) and ensure the correct Project Phase is selected?		
	Am I able to add a Calculated Parameter for "Total Cost," setting the type to "Currency" and ensuring it calculates totals?		

	Have I organized the table by Family and Type, and unchecked "Itemize every instance" to group identical elements for an operational budget?		
	Have I activated "Calculate totals" for the Count and Cost columns, and applied the Euro (€) symbol in the field format settings?		
	Do I know how to create a "Certification" parameter to manage billing progress and link it to colour filters for visual tracking in 3D?		
	Have I created a Multicategory Schedule to act as a quality control tool, ensuring no element in the project is missing a price or description?		
	Can I generate an MCSV file for Arquímedes and understand how to work in a dual mode where selecting a line in the budget highlights the element in Revit?		

9.5.4.2 V8. Material quantity calculation and Cost estimation/ Revit

This teaching material has been designed as a study guide to accompany "**V8. Material quantity calculation and Cost estimation/ Revit"**. Its objective is to serve as written support, following the same structure as the lesson.

This document presents a structured and didactic guide on the use of the Cost-it plugin, a tool designed to act as a bridge between Revit and Presto, allowing efficient management of measurements and budgets (5D BIM).

1. Introduction and Initial Setup

Cost-it works as an extension of Presto that requires a specific license. Once acquired, the client area can be accessed to download the installation files and user guides. After installation, a new tab will appear in the Revit ribbon dedicated exclusively to the functions of this plugin.

Workflow scenarios: There are three main ways to work with this tool:

- **Direct export:** The modeler exports the data to Presto so that a cost technician can work on it independently.
- **Bidirectional workflow:** The studio manages the measurements, exports the data to Presto, and returns the enriched information to the Revit model.
- **Model enrichment:** Presto is used only to add technical and economic information to the model without performing full cost management within the software.

2. The Concept of "Registration" (Linking)

The success of the export depends on the use of codes that unequivocally identify the elements.

- **Assembly code:** It is used as the main "registration number" to associate types of elements (walls, floors, etc.) with specific items in a price database.
- **Keynote:** It is mainly used when working with materials to identify individual components in simple price budgets.
- **Technical note:** If two different elements (e.g., a wall and a window) share the same assembly code, Presto will group them within the same measurement item.

3. Association Phase: Preparing the Model

Before exporting, it is essential to assign price codes to Revit elements.

- **Assign assembly code:** When selecting an element and pressing this button, the price database (e.g., Precco) opens.
- **Item selection:** By choosing the corresponding item, the plugin automatically imports the description, code, and unit price, filling in the "Edit Type" parameters in Revit.
- **Verification through schedules:** It is recommended to create a multi-category schedule to monitor which elements already have an assigned description and code, ensuring the model is fully covered before the final export.

4. The Export Process

When running the Export button, the program reads the visible or selected elements. It is essential to check filters and selections, as these determine what is sent to Presto.

Export configuration options:

- **Coding criteria:** Choose whether the program should group by assembly code or by a custom parameter.
- **Types and materials:** Decide whether to export only element categories, only materials, or both.
- **Measurements:** It is possible to configure the deduction of openings (e.g., ignore openings smaller than 1 m^2) and add room or grid references to locate measurement lines.
- **Attached elements:** Miniatures (3D snapshots), complete families (RFA), drawings, or even IFC files can be included so that the recipient of the budget better understands the project.

5. Management in Presto and Bidirectionality

Once the *.presto* file is generated, the program organizes the information into chapters by Revit categories (Walls, Floors, Columns, etc.).

Each category contains the model types with their respective measurement lines already calculated.

Localization tools: Cost-it enables smooth communication between both programs:

- **From Revit to Presto:** The “Locate” button allows finding the exact measurement line in Presto for a selected element in Revit.
- **From Presto to Revit:** By right-clicking on an item or measurement line, the program can be instructed to select or highlight the corresponding elements in the 3D model. This is crucial for detecting errors or missing elements.

6. Professional Recommendations (Pro-tips)

Layered modelling: For optimal export, it is preferable to model each layer of a complex wall as an independent single-layer wall. This allows each material to be assigned to a different item and managed by different trades without manually duplicating measurement lines in Presto.

Use of templates: Maximum efficiency is achieved by working with templates that already have assembly codes and keynotes preloaded. In this way, budget export becomes an almost automatic process.

7. Practical exercise.

Using the provided building model in Revit format, treat to apply the tools you have learned, as demonstrated in the lesson video.

File name: M4_V8 Revit ARCH

8. Self-Assessment Checklist: V8. Material quantity calculation and Cost estimation/ Revit

Video Code and Title	Technical Criteria to be Checked	Status (Y/N)	Instructor Note / Score
V8. Material quantity calculation and Cost estimation/ Revit	Have I verified that the license is active in the client area and correctly installed the Cost-it plugin in Revit?		
	Am I able to distinguish between the three workflows: direct export, bidirectional workflow, and model enrichment?		
	Am I able to distinguish between the three workflows: direct export, bidirectional workflow, and model enrichment?		
	Do I know how to use the Keynote to associate specific materials with simple prices in Presto?		
	Have I checked that the view filters and element selection match what I want to export?		

	Have I correctly configured the deduction of openings (e.g., subtract openings >1 m²) and the references to rooms or grids?		
	Have I included useful additional information such as thumbnails (3D snapshots), families (RFA), or IFC files in my export?		
	Have I created a multi-category schedule to audit that all elements have description, code, and price before exporting?		
	Do I know how to use the Locate button to find measurement lines in Presto from Revit and vice versa by right-clicking?		
	Have I applied the layer separation technique (modelling each material as an independent wall) to facilitate management by trades?		

1.6 Final Exam

Choose the correct answer (A, B, C or D). Only one answer is correct.

1. **Which visual tool in Revit allows you to "cut" the 3D model to see how floors and walls are constructed internally?**
   A. Progressive Zoom.
   B. Section Box.
   C. Photographic Camera.
   D. Material Brush.

2. **While navigating in 3D, what do "shimmering" or "flickering" effects between two objects (such as a column and a wall) indicate?**
   A. The model is very well lit.
   B. The material is glass.
   C. A conflict or double counting of elements.
   D. The construction work is already finished.

3. **In Revit, if an object was already on-site before the project began, which phase is it in?**
   A. New Construction.
   B. Temporary.
   C. Existing.
   D. Demolished.

4. **What is the primary function of the 4D dimension in a BIM environment?**
   A. Calculating the weight of the furniture.
   B. Linking the model with time (construction scheduling).
   C. Printing plans on larger paper.
   D. Changing the architect's name.

5. **What is the name of the plugin used to connect Revit with the Presto budgeting software?**
   A. Excel.
   B. Facebook.
   C. WhatsApp.
   D. Costit.

6. **Which Revit tool is used to automatically count how many windows or doors are in the model?**
   E. Schedules.
   F. Manual measuring rule.
   G. Text notes.
   H. Red marker.

7. **In a Quality Control Plan, what is the purpose of the "traffic light system"?**
   A. For trucks to know when to enter the construction site.
   B. To use colors to visualize which elements are reviewed, pending, or poorly installed.
   C. To save electricity in the offices.
   D. To decorate the project plans.

8. **In Navisworks, which specific tool is used to create a simulation showing how the building is constructed step-by-step?**
   A. Timeliner
   B. Clash Detective.
   C. Cost Calculator.
   D. Photo Editor.

9. **What is the name of the model that results from joining architecture, structure, and MEP files to ensure everything fits?**
   A. Split Model.
   B. Federated Model.
   C. Plaster Model.
   D. Initial Model.

10. **If we place a crane or scaffolding that will only be used during construction and then removed, what type of object is it according to the phases?**
    A. Permanent Object.
    B. Temporary Object.
    C. Gift Object.
    D. Landscape Object.

Module 5

1. BIM Project Case Study

This final module functions as an independent and self-regulating Final Project Studio. Within this module, a sample project file is provided, including 2D documentation (floor plans, sections, elevations) and 3D visual reference points. Students are expected to independently produce a synchronized multidisciplinary model (architectural, structural, and mechanical) without video instructions, using the theoretical knowledge and modeling skills acquired in the previous four modules.

Critical BIM analyses will be performed on the produced models, including clash detection, time simulations (4D), and quantity-cost estimation (5D).

1.1 Objectives

Capacity Building: To foster autonomous problem-solving and critical design-engineering decision-making in digital project environments.

Transfer of BIM Standards: To implement industry-standard Quality Assurance (QA) and Quality Control (QC) verification protocols at each stage of model progression.

Multi-Disciplinary Collaboration Culture: To master the technical dependencies between separate design files, cultivating a rigorous approach to data consistency and data health.

1.2 Learning Methodology

The methodology is entirely student-centered and project-based, emphasizing self-regulated learning. Students track their development using granular, criteria-driven checklists designed to mimic professional project delivery protocols, verifying the mathematical and spatial accuracy of their models before moving to analysis phases.

Learning Outcomes:

1. Ability to convert 2D paper/CAD documentation into precise parametric 3D BIM components.
2. Ability to define, group, and solve complex building systems.
3. Ability to convert parametric model geometry into reliable data streams for timelines, time tracking, and cost management.

1.3 Training Duration

This module consists of 10 hours of independent project work, supported by self-regulated progress checks.

1.4 Required Teaching Resources

Required Software: Autodesk Revit, Navisworks Manage.

Project Inputs;

- Project PDF file (plans, sections, 3D visual guides).
- Project CAD file ((to be uploaded as a file to the website).

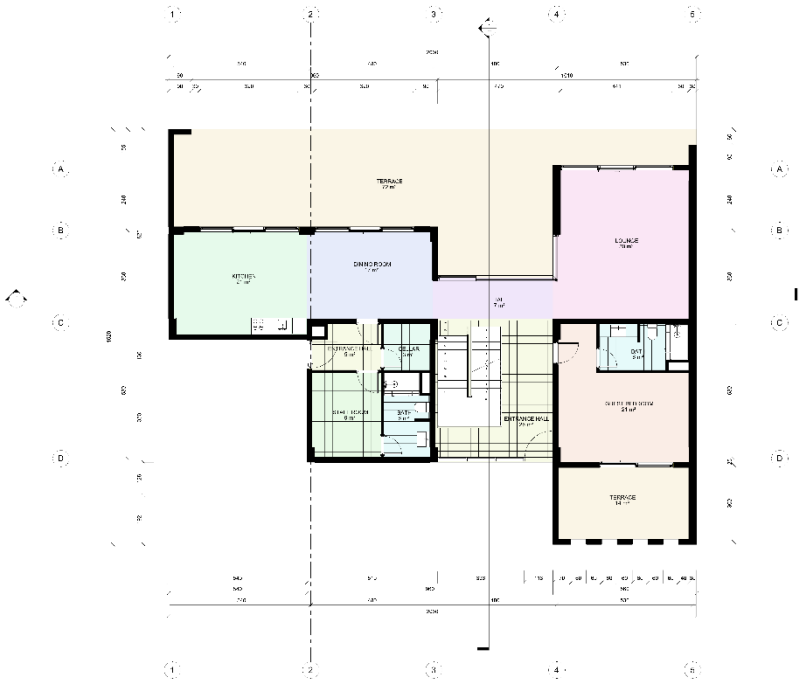


Figure 1. Ground Floor Plan



Figure 2. First Floor Plan

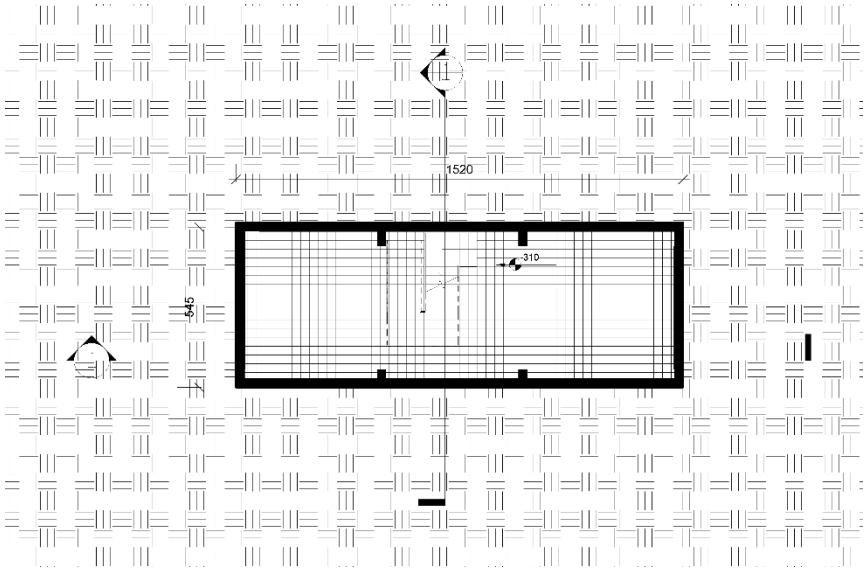


Figure 3. Basement Floor Plan

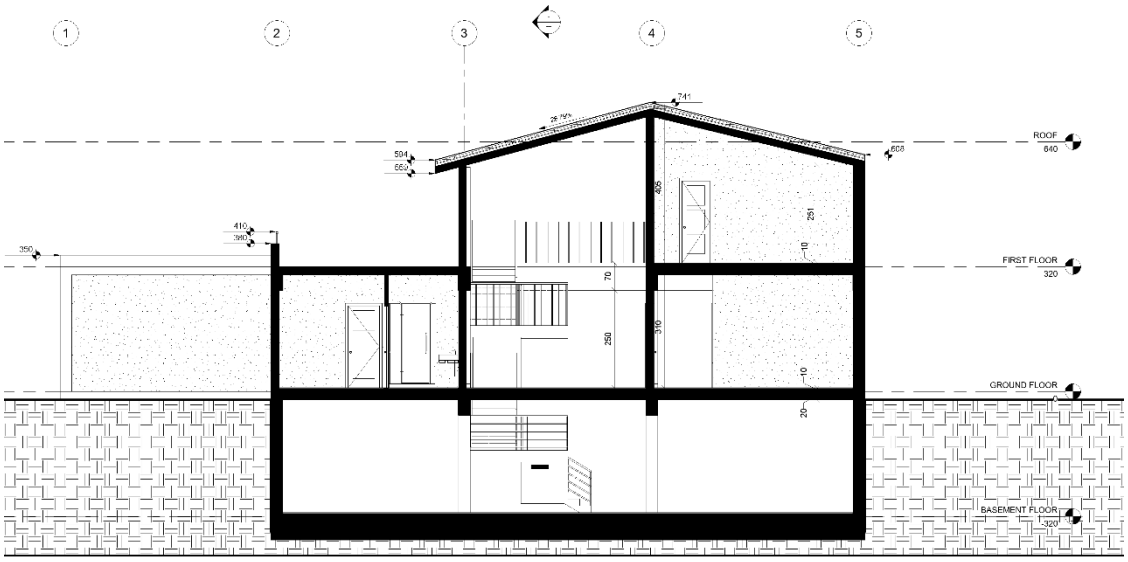


Figure 4. Section 1

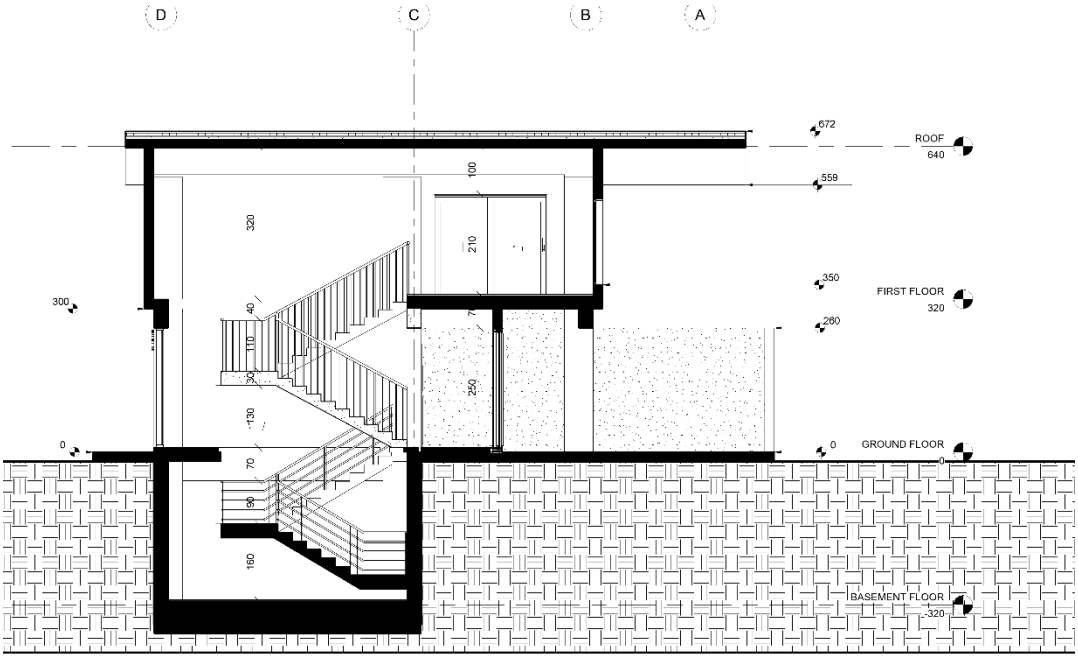


Figure 5. Section 2

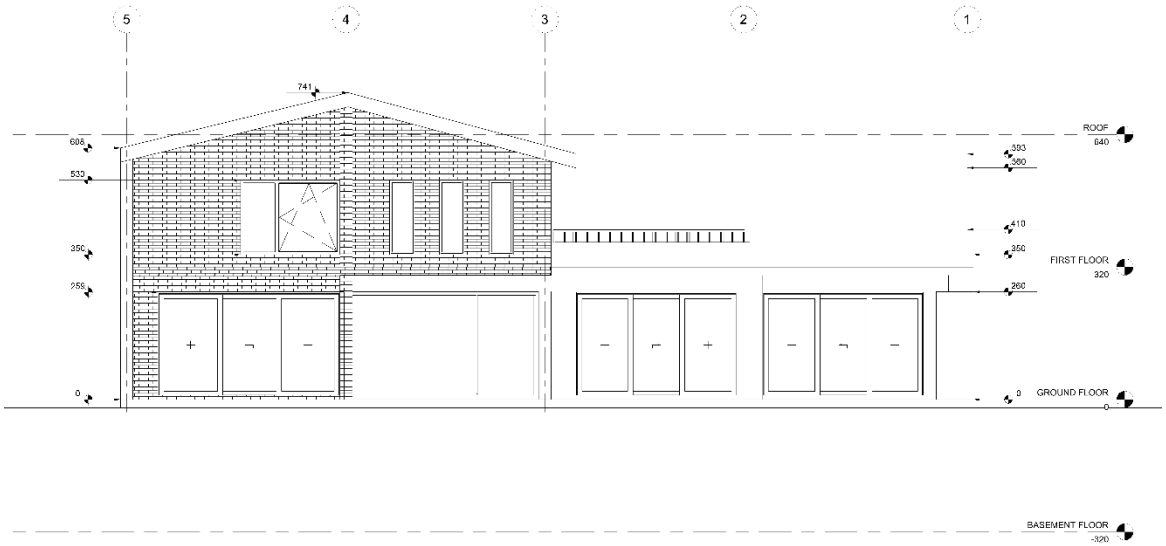


Figure 6. North View

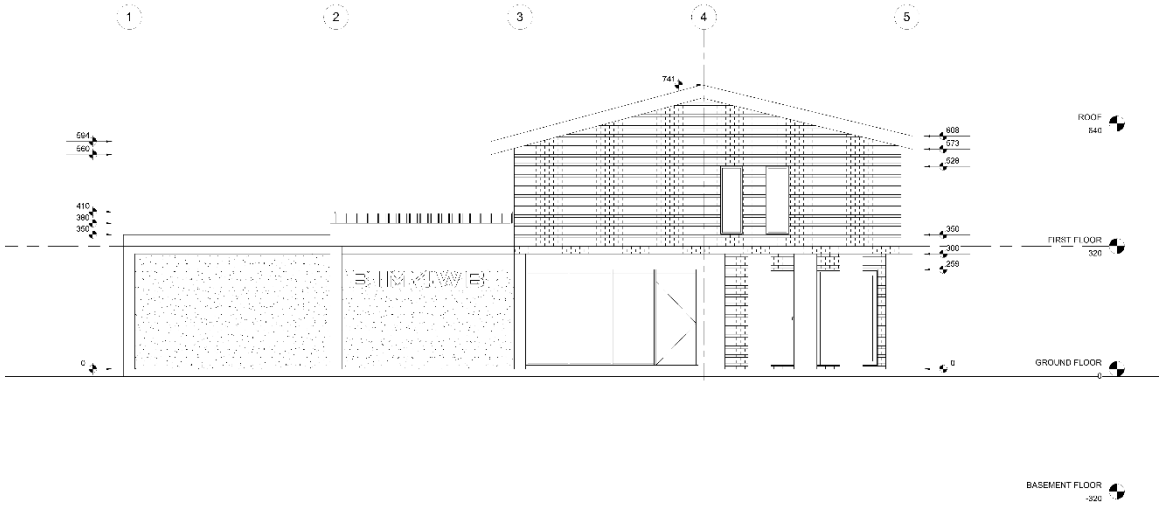


Figure 7. South View

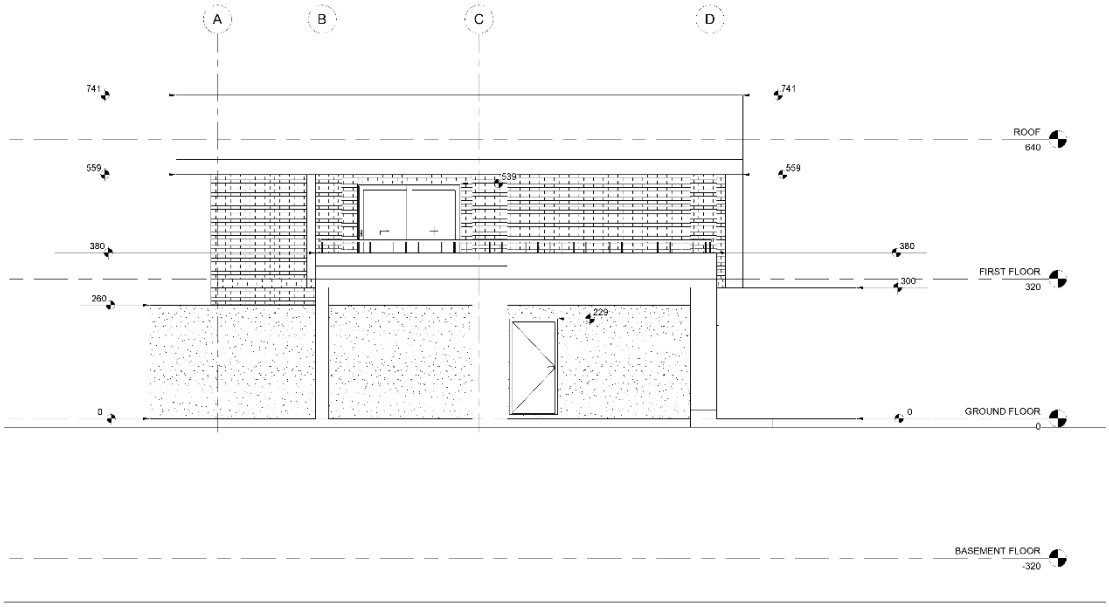


Figure 8. West View

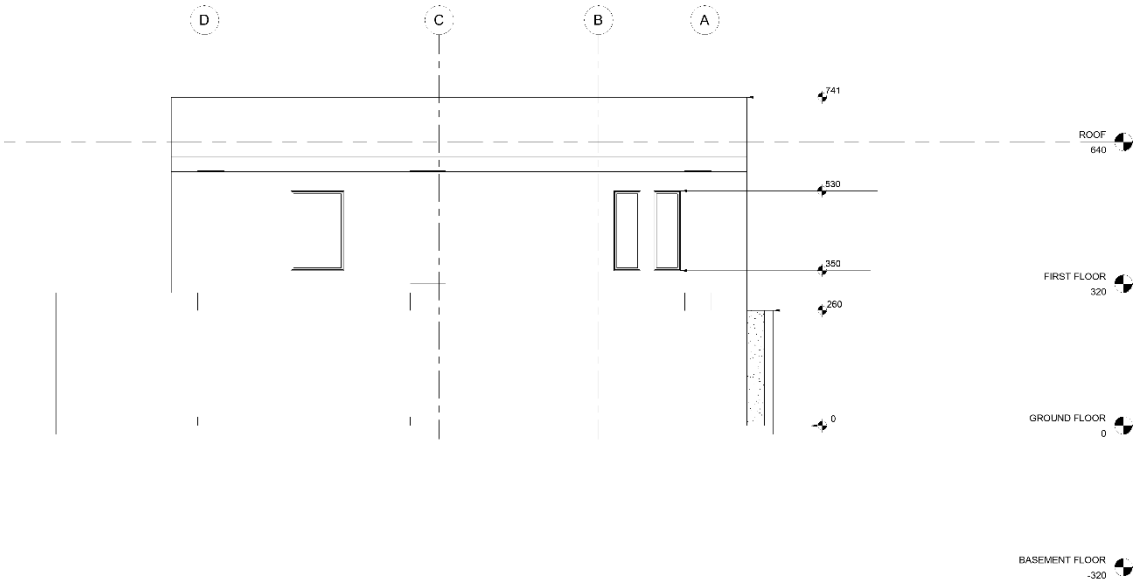


Figure 9. East View

1.5 Course Content

All the videos and supporting documents mentioned can be found in the following link: https://drive.google.com/drive/folders/1_r-siAM-pn1d13G8WupnYsmpEwqbtVkJ?usp=sharing

Final Project: Self-Regulated 3D Modeling & Multi-Disciplinary Analysis Phase

Students must cross-reference their native files with the following step-by-step checklists to ensure structural, spatial, and analytical validity at each stage.

1.5.1. Project Initiation & Architectural Layout (From 2D Documentation to 3D BIM)

Description: Students read the reference drawings, establish the project environment, set units, and construct the spatial grid infrastructure.

Technical Subheadings: Project Template Selection, Grid (GR), Level (LL) Infrastructure, Dimension Constraints.

Student Self-Assessment Checklist:

Technical Subheadings	**Technical Criteria to be Checked**	**Status (Y/N)**
Project Template Selection, Grid (GR), Level (LL) Infrastructure, Dimension Constraints	Is the correct default Architectural Template selected and project units configured	
	Do all horizontal and vertical grid lines (Aks) match the exact alphanumeric labeling in the 2D dossier	
	Are the structural foundation, ground, first, and roof level heights (Levels) cross-checked against the elevation drawings?	

1.5.2 Creating architectural building elements and component placement

Description: Modeling the physical interior and exterior walls, assigning compound layers, and hosting doors and windows matching the sample layouts.

Technical Subheadings: Compound Walls, Component Libraries, Stair and Railing parameters, Room Boundaries.

Student Self-Assessment Checklist:

Technical Subheadings	**Technical Criteria to be Checked**	**Status (Y/N)**
	Are architectural columns aligned precisely at the intersections of the structural grid system?	

	Are column height parameters explicitly bound to the correct Top and Base levels (e.g., from Ground Floor to First Floor)?	
Column Floor Wall (interior, exterior) Door &Window Curtain Wall Stairs Railing Room, room separate Roof Site	Are architectural finish floor boundaries drawn as a closed parametric loop matching the interior finish line of exterior walls? Are finish floors placed at the correct finish elevation, resting flush on top of the structural concrete slabs below? Are structural shaft openings or vertical penetrations sketched inside the floor boundaries where vertical circulation is required?	
	Are exterior walls configured with multi-layered composite definitions (e.g., core, insulation, plaster) matching the exact material thicknesses in the 2D documentation? Are interior partition walls explicitly designated as non-bearing members and aligned to room division lines?	
	Are all doors and windows completely hosted within physical walls instead of floating in empty workspace boundaries? Are door and window family types named correctly according to width-height definitions (e.g., D_90x210, W_150x140)?	
	Are curtain grid spacings, vertical/horizontal layout rules, and mullion profiles sized exactly as illustrated in the elevation drawings?	
	Are stair elements calculated parametrically based on the actual kat yüksekliği (floor height), showing compliant 'Desired Number of Risers'? Are stair landings (sahanlıklar) modeled with appropriate clear headroom clearance and continuous monolithic joins?	
	Are all balconies, voids, and staircases outfitted with continuous railings at the mandatory regulatory height?	
	Is every enclosed spatial volume assigned a distinct 'Room' component, populating	

	automated labels with correct room names and number sequences?	
	Are roof boundaries generated as a valid closed loop, aligned to the exterior core boundaries with appropriate eave (saçak) overhang extensions? Are all perimeter walls successfully attached (Attach Top/Base) to the underside of the roof deck to close envelope gaps?	
	Is the topography (Toposurface or Toposolid) generated accurately from the official 3D CAD contour reference points or point cloud elevations?	

1.5.3 Structural model creation

Description: Independent creation of the building's skeleton on the generated grids. Column and slab transfer from the architectural model, Creation of beams and foundations.

Technical Subheadings: Column, Slab, Beam, And Foundation

Student Self-Assessment Checklist:

Technical Subheadings	**Technical Criteria to be Checked**	**Status (Y/N)**
Column, Slab, Beam, Foundation	Are structural columns aligned exactly at the center intersections of the architectural grid layout?	
	Do structural slabs align below the architectural finish floor, resting correctly on top of structural beams?	
	When switching to the 'Analytical View', do all structural nodes seamlessly connect without breaks or floating members?	

1.5.4 Mechanical (MEP) system coordination and connection

Description: Routing air distribution networks, mechanical equipment, and plumbing pathways throughout the architectural spaces.

Technical Subheadings: Pipe, Drainage, Connectors.

Student Self-Assessment Checklist:

Technical Subheadings	Technical Criteria to be Checked	Status (Y/N)
Pipe, Drainage, Connectors.	Are all mechanical equipment correctly classified under relevant systems?	
	To ensure that the created clean water and wastewater pipes do not overlap, were different X, Y, Z coordinates considered when determining the pipeline routes?	
	Has the 'Check Systems' or 'System Browser' tool been run to confirm zero unassigned connections or leaking circuits?	

1.5.5 Federated Model & Shared Coordinates Verification

Description: Combining separate discipline models into an integrated project model using advanced linking protocols.

Technical Subheadings: Link Revit options, Origin-to-Origin coordinate mapping, Shared Coordinate publishing.

Student Self-Assessment Checklist:

Technical Subheadings	Technical Criteria to be Checked	Status (Y/N)
Link Revit Coordinate mapping	Are the structural and mechanical models linked into the master file using 'Origin-to-Origin' or 'Shared Coordinates'?	
	When changing visibility graphics, do all three models match up flush with zero architectural or elevation offsets?	

1.5.6 Automated Clash Detection & Coordination Reporting

Description: Running rigorous interference queries to isolate conflicts between building elements before real-world construction.

Technical Subheadings: Hard Interference Settings, Clearance Tolerances, BCF Export.

Student Self-Assessment Checklist:

Technical Subheadings	Technical Criteria to be Checked	Status (Y/N)
Hard Interference Settings, Clearance Tolerances, BCF Export.	Has an active interference check been executed specifically isolating 'Structural Elements vs. Mechanical Ducts'?	
	Are minor overlapping errors (below 10mm tolerance) ignored to ensure only critical structural clashes remain?	
	Have the identified conflicts been organized into an active coordination spreadsheet or matrix for engineering adjustments?	

1.5.7 5D Quantity Schedules & Cost Estimation

Description: Transforming the 3D geometry into physical quantitative data schedules paired with baseline cost formulas.

Technical Subheadings: Structural Concrete Volume Schedules, Calculated Values, Total Project Budgets.

Student Self-Assessment Checklist:

Technical Subheadings	Technical Criteria to be Checked	Status (Y/N)
Structural Concrete Volume Schedules, Calculated Values, Total Project Budgets	Are total counts for specialized hosted components (Doors, Windows,) displaying matching numbers?	
	In concrete cost estimations, have material quantities been created?	

1.6. Exam

1. When starting 'Project Initiation and Architectural Layout' using 2D paper/CAD documentation, which initial operation is critical to ensure that all multi-disciplinary elements align perfectly in height throughout the project lifecycle?
   a) Applying a high-resolution texture map to the default ground floor plain.
   b) Establishing a precise parametric Level (LL) framework based on structural top-of-slab elevations before modeling any 3D elements.
   c) Locking the project cursor to the default screen aspect ratio.
   d) Exporting the empty workspace directly as an IFC project coordination container.

2. During the creation of architectural building elements, when changing the width of a specific interior door type in the schedule, it was noticed that every single door belonging to that same type across the entire floor plan altered simultaneously by accident. Which concept of the object-oriented database explains this behavior?
   i) The student modified an Instance Parameter instead of a global project setting.
   j) The student modified a Type Parameter, which governs the relational properties of all elements assigned to that specific family type.
   k) The door was modeled as a Curtain Wall element instead of a standard hosted component.
   l) The room separation boundaries were overlapping with the wall location lines.

3. When is the “Location Line” setting selected as "Core Face: Exterior" during wall modelling, which layer is the reference line of the wall aligned with?
   e) It is aligned according to the exact geometric center axis of the wall structure.
   f) It is aligned according to the outer surface of the outermost plaster, insulation, or cladding layer of the wall.
   g) It is aligned according to the outer face boundary of the wall's main structural core layer (Core Boundary).
   h) It is aligned according to the core boundary facing the interior space side of the wall.

4. While executing structural model creation, why is it necessary to model load-bearing members using specific 'Structural Column' and 'Structural Beam' tools rather than basic architectural elements?
   e) Architectural elements are completely invisible in 3D perspective views.
   f) Structural components generate a synchronized 'Analytical Model' (linear skeleton path) required for calculations in downstream structural analysis software (FEA).
   g) Architectural categories automatically inflate the total volume metrics by 50% in schedule tables.
   h) Structural profiles prevent any mechanical systems from linking into the file as an underlay.

5. In mechanical system coordination and connection, what is the primary technical function of the Connector embedded within mechanical equipment families (e.g., HVAC units, combi boilers)?
   e) To automatically calculate the market cost of the equipment based on current project schedules.
   f) To establish the logical database link between equipment and distribution networks (pipes/ducts), dictating flow direction, system classification, and fluid properties.
   g) To compress the physical size of the geometry to fit inside narrow ceiling voids.
   h) To link the physical model directly to external presentation and rendering engines.

6. What occurs if separate architectural, structural, and mechanical models are linked together using the 'Project Internal Origin' option instead of establishing 'Shared Coordinates'?

e) The project file automatically corrupts and deletes all hosted families within the workspace.
f) The models may displace or scatter inaccurately across the workspace if the individual discipline teams started drafting from different base positions.
g) The material takeoff schedules combine all costs into a single currency format automatically.
h) The structural analytical lines are forced to convert into mechanical ventilation ducts.

7. When configuring an automated test during automated Clash Detection, why should a coordination manager apply a specific tolerance margin (e.g., 10mm) instead of leaving it at zero?
   e) To increase the total number of clashes reported, ensuring a more thorough document review
   f) To filter out negligible millimeter-scale overlaps or real-world construction tolerances, ensuring the coordination team focuses solely on critical structural interferences
   g) To automatically modify the physical diameter of mechanical pipes on the model.
   h) To rewrite the timeline scheduling properties of structural foundations.

8. After running a clash test, you receive an unorganized list containing 800 individual interferences. What is the most efficient method to manage this data stream before issuing revision tasks to design teams?
   e) Group related clashes systematically by Level, Category, or System Type within the coordination software.
   f) Print 800 separate pages of drawings and circle each interference manually using red ink.
   g) Delete the entire mechanical model link to clear the conflict logs immediately.
   h) Change the project unit format from millimeters to meters to reduce total numbers.

9. Within a Revit schedule view, how is the total financial budget for a reinforced concrete core structure calculated?
   e) By exporting a 3D rendering to an external photo editor to count pixels.
   f) By creating a 'Calculated Parameter' (Calculated Value) using a formula that multiplies the extracted physical material volume (Material: Volume) by a defined unit price parameter.
   g) By linking the project base point coordinate directly to regional banking servers.
   h) By applying a phase filter that flags all elements as 'Demolished'.

10. When dealing with multi-layered components (like a composite insulated exterior wall), why does a 'Material Takeoff' schedule for 5D cost estimation deliver much more precise results than a standard 'Component Schedule'?
    e) Material takeoffs can break down and calculate the individual volumes of each separate sub-layer material (brick, insulation, plaster, etc.), rather than just reporting the overall total block volume of the wall element.
    f) B) Material takeoffs automatically correct structural modeling errors made by students.

g) C) Component schedules completely ignore window and door opening dimensions.
h) D) Material takeoffs modify the shared coordinate framework of linked mechanical files.

CONCLUSIONS

The deliverable D3.3 *Report on Material Development* presents the successful development of the teaching and learning materials for the BIM4WB programme, based on the curriculum structure established in D3.2., into a progressively course to be tested. The materials follow a modular structure, complying with the learning outcomes, strategy, and common standards defined during the curriculum design phase, which ensures consistency across all modules and progressive learning.

The materials developed provide complete practice-oriented training, that includes theoretical content, practical exercises, instructional videos, exams, self-assessment activities, and supporting materials. Their practice-oriented design supports the progressive acquisition of BIM competencies at VET level, enabling learners to develop the technical skills required to address current industry needs within Albania and Kosovo.

The collaborative development process, supported by common templates, software (REVIT), and continuous partner review, facilitates consistent delivery during testing and the future implementation of the programme across partner institutions.

With the educational resources completed, D3.3 establishes the foundation for the next phase of the project: testing and implementation.