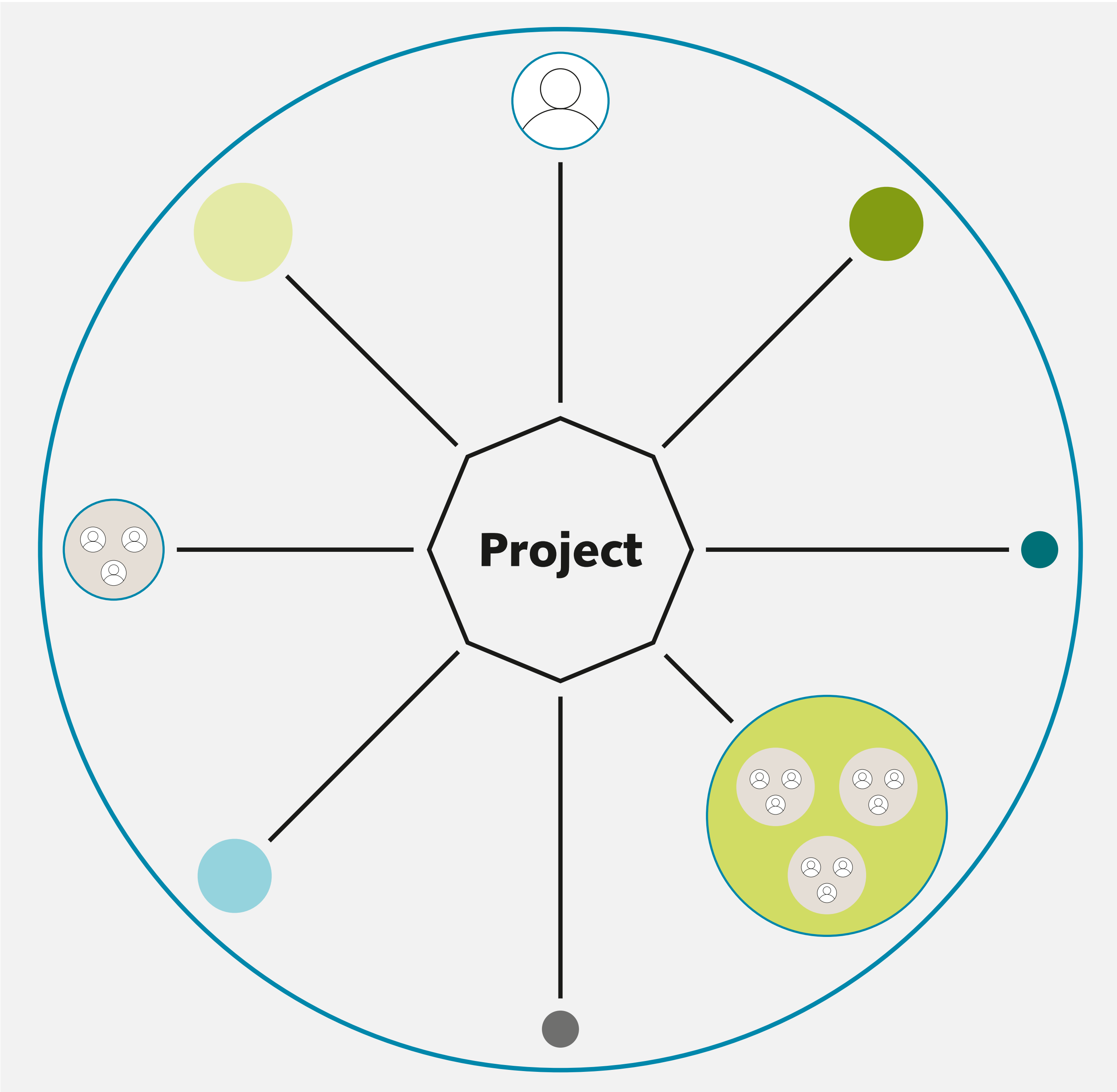
Lignatec

Project Management with BIM in Timber Construction



buildingSMART Switzerland
Holzbau Schweiz
Lignum

Content

1 Foreword

In the mid-20th century, the differing cost developments of materials and labor led to a shift in the composition of construction prices. While building materials became significantly more cost-effective due to continuous production improvements, the efficiency in planning and executing buildings remained largely unchanged. As a result, labor-intensive construction methods such as timber construction increasingly lost competitiveness compared to newer building techniques. In addition multi-story timber construction was long prohibited for fire safety reasons.

It was only through research into the development of new engineered wood products and the prefabrication of digitally planned building systems using modern processing machinery, that timber construction began to regain its appeal in the 1990s. With the lifting of the last fire safety restrictions for wood construction in 2015 and an increasing focus on sustainability, timber construction was able to reestablish itself. Today, timber buildings offer high planning and cost certainty, provided that the approach across all project phases is adapted to the specific requirements of timber construction. The advantages of timber construction include high execution quality through prefabrication and significant time savings on the construction site, making timber construction particularly attractive for urban densification projects. The current state of technology also enables multi-story timber construction projects, ranging from large residential developments to free-form structures.

Project participants are supported in planning, production, and assembly by digital tools and methods. Timber construction specialists create digital models that are consistently used from execution planning through to assembly. However, efficient planning in timber construction requires clear principles and coordinated rules. For prefabrication, production documents must be planned collision-free across trades, and the connection details must be designed to be practical. In addition, these documents must be usable for processes such as material procurement and machine control.

To ensure efficient collaboration in a project, the necessary foundations for communication should be established within the team at the very beginning of the project and continuously updated. The tasks in timber construction projects are diverse, and complexity steadily increases as the project progresses. As illustrated in the graphic on the title page, the achievement of the project goals is central, serving as a constant guide for project management throughout the entire project. Therefore, project execution with BIM in timber construction is not primarily about technical details but rather about a methodical approach that is closely aligned with the project objectives. This publication is intended to serve as a practical guide for all construction stakeholders, fostering a shared understanding of the effective use of the BIM (Building Information Modelling) method in the planning and implementation of timber construction projects.

2 Introduction

2.1 The initial situation

The construction industry continues to exhibit lower productivity and a limited degree of digital integration compared to other sectors. In addition, it is characterized by high levels of waste and significant energy consumption, which substantially contribute to global emissions. Transforming this sector toward a sustainable and circular economy requires innovative solutions and targeted measures. Timber construction is part of the solution: wood is not only a renewable and readily available raw material but also offers high load-bearing capacity at low weight and is easy to work with. Combined with the extensive expertise of qualified professionals, the forestry and timber industry can significantly strengthen regional value chains, the circular economy, and the bioeconomy.
A key foundation for transforming the construction industry is seamless data structures and professional information management, which begins with the data of construction products. This supports the development, operation, and maintenance of buildings significantly and forms the basis for lifecycle optimizations. Seamless information chains provide various advantages, such as increased transparency, simplified communication, and precise, data-based decision-making. Implementing such data structures is less of a technical challenge and more of an organizational one that must be addressed systematically.
As early as the 1980s, the timber construction industry began exploring and implementing data exchange processes between computer-aided design (CAD) and automated manufacturing (CAM). This led to solutions that overcome interface issues between planning and production data for machine control. Through the continuous integration of digital planning processes and data-driven manufacturing, timber construction has established itself as a leading sector within the Swiss construction industry, boasting the highest precision and degree of prefabrication.
Currently, approximately 18 % of buildings in Switzerland are constructed with timber frameworks, with 90 % of these buildings being prefabricated [52]. In contrast, most of the remaining construction industry still relies on traditional on-site construction methods. Element and modular construction, as well as off-site prefabrication, have become common practice in Swiss timber construction. Even complex free-form constructions are routinely executed by experienced timber construction companies. These developments result in specific requirements for planning accuracy and data quality that differ significantly from those of conventional solid or on-site construction methods. In timber construction, model-based planning during the execution phase is standard practice, requiring early coordination to achieve high planning accuracy. This also involves cross-disciplinary coordination, system and element thinking, and precise logistics planning. Optimized collaboration and the targeted management of planning, production, and assembly data form the foundation for the success of this construction method, positioning timber construction as an efficient, sustainable, and high-quality building alternative. Finally, the Lignatec ‹Project Execution with BIM in Timber Construction› serves as a pioneering example for the digital transformation of the entire construction industry.

2.2 Collaboration and networking in the construction industry

A prerequisite for prefabrication in timber construction is fundamentally a close collaboration between planners and implementers, as well as the coordination of all building components with their respective production and assembly conditions. Therefore, the available standard sizes of timber construction products and the project-specific possibilities for production, transport, and assembly must be aligned already during the planning phase. This requires systematic thinking, interdisciplinary collaboration, and a deep understanding of processes across the entire project team.
Communication has always been indispensable in the construction industry and is becoming increasingly demanding and interconnected due to rising requirements for buildings. Numerous publications from the 1990s, which first examined this issue in depth, underline the potential of digital tools for error reduction, efficiency enhancement, and improved project communication. In this context, the interfaces of the software systems used represent a constant challenge. To improve the interoperability of building data among various software solutions in construction, buildingSMART International developed the open and standardized data format IFC [33]. Moreover, the interoperability of structured data can be supported through ontologies, which are recorded in shared dictionaries such as the bSDD [55] and are

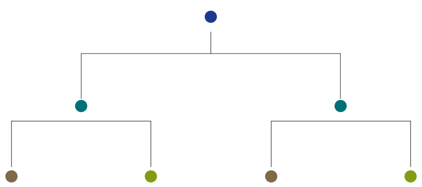
publicly accessible. Such language-independent and machine-readable data are the prerequisite for building modeling with integrated information.

This application guide is intended to provide the basis for ensuring both the interoperability between the plans of all construction stakeholders and the consistency of data throughout all planning phases up to the completed building. It also includes the clear organization of specific responsibilities and workflows in timber construction among the project participants.

‹Leistungsmodel 95› of 1996

As early as 1996, the Swiss Society of Engineers and Architects (SIA) noted in the accompanying document to ‹Leistungsmodell 95› [30] that what is required is not merely the sum of individual services, but rather an integrated overall service provided by various disciplines. It is also emphasized that the quality of planning strongly depends on the functionality of the planning team. Team-oriented planning is highlighted as an essential component of project execution. This does not merely involve joint coordination meetings, but rather an in-depth engagement of all participants from different disciplines with their respective tasks, motivations, and interests in relation to the project objectives.

Figure 1
Linear action model [20]

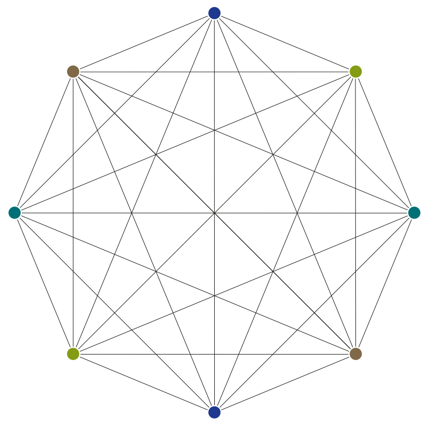


Even in this document, sustainability is addressed: only through teamwork can requirements such as ecological and energy-efficient construction be effectively combined with the demand for cost-effective building and operation.

‹Vernetztes Planen im Holzbau› of 1998

The Lignatec 6 from 1998 with the translated titel ‹Networked Planning in Timber Construction› [20] emphasizes the necessary shift from a linear to a dynamic and holistic project organization in order to meet the increasingly complex construction challenges.

Figure 2
Networked cooperation [20]



It also points out the decreasing half-life of acquired knowledge due to global networking and underlines the potential of continuous learning through interdisciplinary project collaboration as a solution.
Due to the rising complexity of construction projects, there is a growing need for specialization among project participants as well as the early inclusion of construction expertise. This networked collaboration among project participants results in the expansion of one's own specialized knowledge by incorporating the expertise of project partners. This mutual educational effect eventually leads specialists to function much like generalists—operating at the most current and highest level.

From networked cooperation to holocratic project alliances

The insights from the two foundational documents, which are now over 25 years old, are more relevant than ever. The increasing scarcity of non-renewable resources and climate change pose enormous challenges to humanity. At the same time, rapid advances in digital technologies are opening up new possibilities for transdisciplinary collaboration, communication, and innovation. Common conventions are indispensable: thanks to standards at the national level (SN) and international level (ISO, EN), as well as the network and standards of buildingSMART, we have a solid foundation for targeted and situation-specific communication.

Eliminating barriers and incentivizing collaboration
In order to fully benefit from these basic standards and the technologies they enable, obstacles in collaboration must be removed and incentives for partnership models must be created. In the Swiss construction industry, the SIA leaflet 2065 ‹Planning and Building in Project Alliances› is available as a suitable tool for this purpose. With this method of project execution, risks and opportunities are jointly shared, resulting in synergies that are not possible in traditional hierarchical project management.

Holacracy and integrated project execution
The basis of this collaboration is the holocratic organizational concept, according to which specialist areas share responsibility and jointly develop integrated solutions, as is the goal in integrated project execution. These models of collaboration not only generate innovative solutions, but also make it possible to optimize buildings as holistic systems throughout their life cycle. Project alliances and holacracy create an environment in which every team member can actively contribute to continuous improvement. They foster a culture of knowledge sharing and collaboration, which is essential for successfully managing the complexity of modern construction projects.

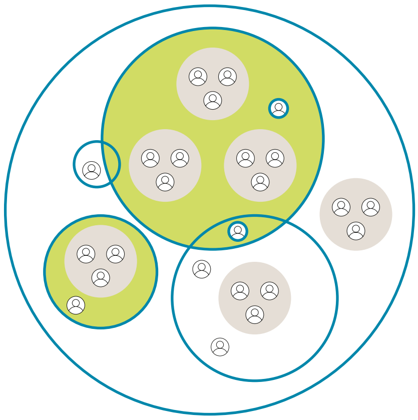


Figure 3
Holocratic organization of cooperation

2.3 Purpose of this application guide

This application guide provides an overview of the existing framework conditions and best practice examples, such as seamless information structures and digital models, that can optimally support the planning and execution of timber construction. The document explains the fundamentals of project execution based on the BIM method, highlights key aspects of timber construction, discusses the main topics of BIM project execution, and offers an outlook on current developments that will shape digitally supported project execution in the future. It serves both as a basis for communication among all parties involved in timber construction projects using the BIM method and as an introduction and practical guide for timber construction professionals working with BIM. In addition, it explains why the use of the BIM method in timber construction is beneficial and outlines the advantages it can deliver. Finally, it details who should provide what, when, and how, to ensure optimal results in timber construction projects.

2.4 Delimitation of the content

This document is not a general template for BIM project execution plans, but rather a practical guide for the application of the BIM method in the execution of timber construction projects. It also does not contain any recommendations regarding timber-specific information requirements for clients or the involved planning disciplines. As in traditional project execution, different contractual models have also emerged for the BIM method. This document does not provide any recommendations regarding contractual arrangements or legal provisions related to BIM.

Best Practice

In all chapters, additional best-practice examples are highlighted in brown to facilitate understanding and support practical application. These examples demonstrate how collaboration in timber construction projects can be optimally designed using digital data models.

3 BIM and timber construction

The BIM method can be applied along the entire value chain—from development through planning and execution to operation, deconstruction, and reuse. Its success depends crucially on the continuous availability of information and data in consistent quality.

Efficient data utilization: The basis for a sustainable construction industry

The data used in the BIM method must be consistent, structured, and provided according to recognized standards such as IFC or bSDD to enable seamless collaboration and interoperability. This ensures that the data can be verified and reused for various purposes over the entire life cycle of a building, encompassing different disciplines and tools. These standards create transparency, boost productivity and efficiency, and lay the foundation for a sustainable transformation of the construction industry. To fully exploit these benefits, it is necessary to gradually learn how to work with interdisciplinary teams, structured data models, seamless information flows, and digital tools—and to adapt these practices to company-specific processes.

Material characteristics of timber

Timber, as a building material, has significant differences compared to other materials that must be considered during planning. Its static properties are direction-dependent; for example, the material is strongest in tension and compression along the grain. Modern adhesives and processing technologies have expanded the dimensions and applications of timber: today, the maximum size of timber components is less limited by production capabilities and more by the ability to transport them to the destination.

Consideration of standard dimensions and reuse

Even in the early planning stages, standard dimensions of timber and engineered wood products should be taken into account, whether it concerns sawn timber, glued laminated structural elements, or large-format wood-based panels. Modern timber construction typically consists of prefabricated building elements that are assembled on site. Building systems can be designed with detachable connections so that individual components, at the end of their life cycle, can be disassembled without damage and reused or recycled. A detailed and up-to-date digital building documentation is a prerequisite for this.

3.1 Basics of project management

Project definition

The project definition provided by the client establishes the most important target values, functions, and framework conditions of the construction project. Typically, the project definition remains unchanged throughout the entire planning and construction process. [34]

Project requirement specifications

The project requirement specification encompasses the functions and characteristics of the building necessary to achieve the target values set in the project definition, as well as the project's structural and procedural organization. At the conclusion of each subphase, the project requirement specification is updated in a graded manner based on the results by the overall manager and the client. [34] Fundamental components of the project requirement specification include, for example, usage agreements and project deadlines

Use cases

To achieve the objectives defined in the project requirement specification, appropriate measures must be implemented. In the context of the BIM-method, these measures are referred to as ‹use cases.› The use cases define the processes, the involved actors, the information to be processed, and the information structures to be applied, which are necessary to achieve a specific benefit using digital tools. Proven use cases are, for example, collected on the buildingSMART Use Case Management Platform and made publicly available. Within a use case, it is detailed which deliverables must be provided in which form (models, plans, documents) and how their contents should be structured and developed. [13]

The following key questions are answered:

Why What is the goal, purpose and expected benefit?

When When is the time of information delivery depending on the use of the information?

Who Which actors are involved and need, check and/or provide the information?

What Which delivery objects are required in which structure?

How Form and content of the information in terms of geometry, relations, alphanumerics and/or supplementary documentation?

Best Practice

In the project definition or specification, the client may express a clear desire to use BIM for project execution. However, digital tools and methods like BIM should not be used just for their own sake. When choosing BIM, it must be clear what goals are being pursued and what results are expected, such as specific benefits or added value. The chosen measures must always match the project's actual objectives. If they do not, a discussion should be held to agree on common goals and the best way to achieve them.

The planning and execution of projects using digital building models should always be guided by a BIM Execution Plan (BEP). This plan sets out the agreed basics, goals, conditions, roles, responsibilities, and technical guidelines. The BEP forms the basis for the contractual agreements between the parties regarding the use of the BIM methodology.

Best Practice

Some examples of objectives and corresponding measures are presented here as use cases to illustrate the necessary level of information detail and the advantages of model-supported project execution. These use cases clarify specific information requirements and demonstrate how digital models can effectively streamline project processes.

Goals and benefits	Measures
Shorter construction time Reduction in interest costs, earlier rental income.	Process planning and review focusing on reducing construction time by considering prefabrication options for building elements and logistics at an early stage.
High level of detail in execution planning Greater cost and schedule security.	Process planning and review focusing on ensuring a high level of detail in the early planning phases of the involved and adjacent trades
Prefabrication in a controlled environment Higher quality and precision.	Detailed coordination of building modeling with the elements contained in the wooden components and the adjacent trades. ‹BIMwood Digest 2 Process Level 3› provides suggestions for this. [16]
Weight reduction Lower foundation costs for weak soil conditions, ideal construction method for building extensions	Selection and coordination of lightweight construction systems. The requirements for coordination are provided in the Use Case for component requirements in timber construction. [24]
No moisture during construction Dry construction method—reduced construction time due to elimination of drying phases, improved indoor climate	Selection and coordination of construction systems and assemblies in dry construction methods, along with process planning based on the required material quantities
Gain in usable floor space More usable area through slim construction with the same insulation performance as compact constructions	Selection and coordination of ideal component assemblies with minimal structural thickness.
Quality assurance from project start to completion Consistent use of planning models for production and assembly to ensure quality and efficiency	Early clarification of information interfaces between planning disciplines and execution teams. ‹BIMwood Digest 3› provides recommendations on information requirements. [17]
Sustainability Use of wood as a naturally renewable and locally available resource	Defining origin declarations, sustainability labels, and appearance classifications according to usage requirements. Optimizing material demand and verifying timely availability in the market.
Ecological performance Reduction on environmental impact compared to other construction methods and lower environmental impact	Selection and optimization of components based on their environmental impact or carbon storage potential. The component database www.lignumdata.ch provides a solid data foundation for this.

3.2 Understanding timber construction systems

Timber construction is a system-based approach in which different structural systems can be distinguished. Each system offers its own specific advantages and conditions dictated by its inherent system logic. The structural framework may even be composed of various timber systems. Although a purely timber structure is technically feasible, the load-bearing framework is often combined with other materials—such as concrete or steel—in hybrid construction.

Therefore, it is crucial for the planning team to agree on which building components and elements correspond to which system logic and material application. Accordingly, the following overview presents the most common timber construction systems as a basis for coordination.

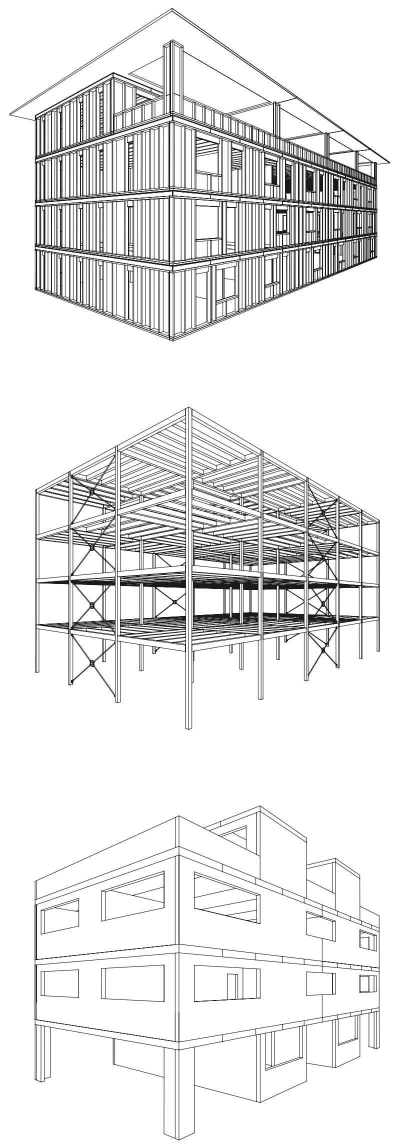


Figure 4:
Timber construction systems

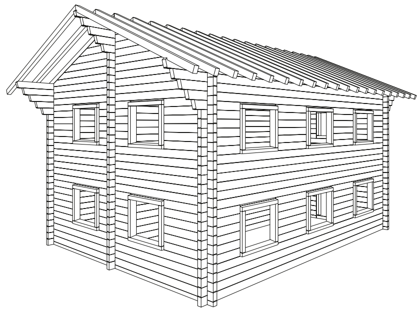
Timber frame construction
This method of prefabricated construction is currently the most important building system in European timber construction. The lightweight elements consist of a continuous peripheral frame, with the intermediate spaces filled at regular intervals with studs or ribs. The framework is sheathed on both sides with wood-based panels or gypsum boards. Thermal insulation is directly integrated into the timber frame, allowing for slimmer wall assemblies compared to solid construction methods and thereby yielding significant space savings.

Skeleton construction
These wide-span column-and-beam structures, characterized by clear design principles, offer significant flexibility in design. Constructions using glulam beams can be curved or designed as truss-like systems to define spatial volumes, thereby enabling impressive interior forms. Timber skeleton construction is particularly suited for large-volume buildings with wide spans. It offers the advantages of flexible spatial arrangements with non-load-bearing lightweight partition walls, as well as the possibility of designing the facade independently of the structural framework.

Mass timber construction
In mass timber construction, the load-bearing system is comprised of large-format panels. These panels may be made of cross-laminated timber (CLT), doweled plank stacks, or glued laminated timber. Because these components can serve both structural and spatial functions, the number of layers and materials in interior partitions can be reduced. However, exterior walls still require additional cladding and thermal insulation, similar to masonry or concrete constructions. The structural system of mass timber construction can carry both vertical and horizontal loads, which makes it easier to calculate structurally. On the downside, this system typically requires a higher volume of wood, a factor that must be considered from an ecological perspective.

Timber block construction

Timber block construction is a very old method of solid timber construction. In this method, horizontal round or squared timber logs are stacked so that they interlock at the building's corners. Today, advanced block construction systems are available that integrate thermal insulation while maintaining the visible aesthetic of traditional log construction. However, since wood undergoes significant dimensional changes across the grain, this method is not used for larger structures, as the resulting deformations cannot be adequately accommodated in the design.



Modular construction

Modular construction refers to the method in which entire rooms or sections of rooms are pre-assembled in the factory using various elements (floor, wall, and ceiling components). These prefabricated room modules are then equipped with building services—or even completely finished—before being transported. The dimensions (length, width, height, weight) of these modules are determined by what can be produced logistically in the factory and subsequently transported by truck and installed based on the site conditions. All the previously described timber construction systems can be used in modular construction.

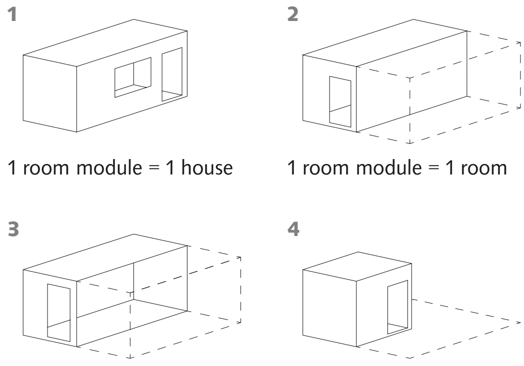


Figure 5
Variants of modular construction [56]

1 Single module
2 Closed module
3 Open module
4 Bathroom module, kitchen modulel

Hybrid construction

Hybrid construction combines building components made from different materials (e.g., clay, steel, reinforced concrete, or brick with timber elements). For example, massive concrete column-and-slab structures are combined with pre-fabricated external walls made of timber elements. Such facade systems are significantly lighter and slimmer than conventional compact facades made of brick or concrete. Thanks to the use of timber, a building constructed in a hybrid manner also achieves a better ecological balance compared to buildings using other construction methods. Timber-concrete composite systems (TCC) have proven particularly effective for ceilings in hybrid construction.

3.3 Use cases and processes in timber construction

For the efficient implementation of various timber construction systems, specific planning methods and production processes have been developed in timber construction that differ significantly from those used in conventional on-site building methods. In timber system construction, planning services and compensation are shifted to earlier phases compared to the phase contents defined in SIA 103 [36]. To illustrate these differences, several exemplary cases will be described.

3.3.1 Changed planning and fabrication processes

In Switzerland, timber structures are predominantly prefabricated, achieving a prefabrication rate of 90 % in timber construction [52]. The most common system construction method is timber frame construction, which is built in an inhomogeneous manner. One layer of components consists of several building products, each fulfilling a different function. For example, the load-bearing structure—composed of linear components such as beams or studs—is simultaneously integrated with thermal insulation materials. In contrast, solid construction methods are built homogeneously, with each layer having its own specific function, allowing them to be planned separately and at different times.

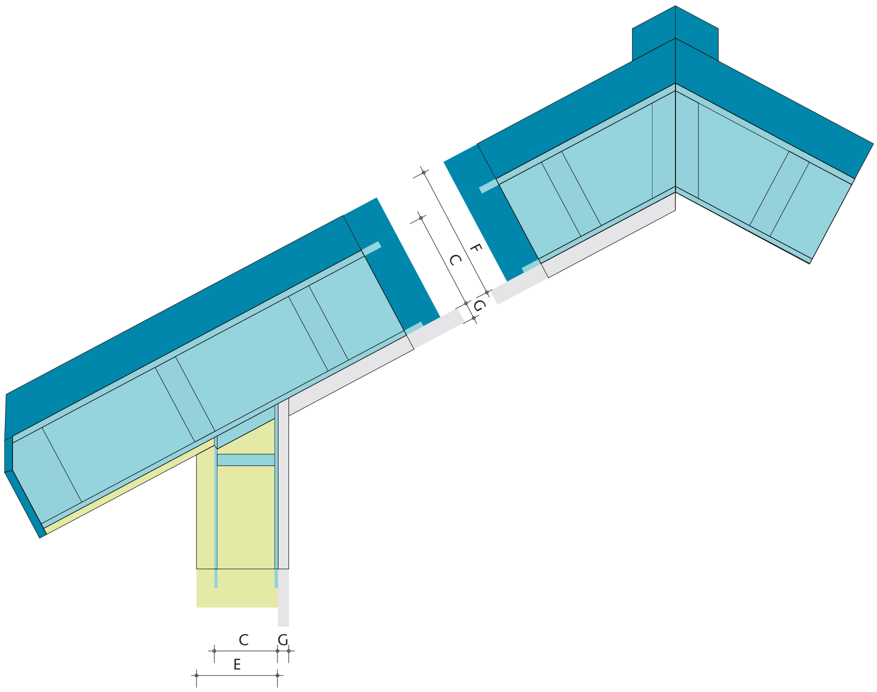
In solid construction, where structures are made of concrete or brick, the load-bearing framework is typically built on-site, which is why this method is also known as on-site construction. The insulation is added later either on the interior or exterior. In contrast, timber systems can achieve the same performance with thinner components, saving space and enabling larger usable areas in the constructed buildings. However, timber systems require, in addition to structural design, the consideration of numerous additional requirements—such as fire protection, thermal insulation, and sound insulation—that interact with one another. Therefore, to design a building as an integrated timber system, timber engineers must address many more issues concurrently during the structural planning process.

Table 1
Overview of differences between solid construction and timber construction systems

Solid construction	Timber construction systems
Component structure	
Homogeneous (one material fulfills one main function per component layer)	Inhomogeneous (multiple materials serve different functions within one component layer)
Building material per layer	
One building material per layer	Various building materials per layer
Planning the component layers	
Separate, possible in different planning phases	Simultaneous, integrated planning required
Structural design	
Built on-site (on-site construction)	Prefabrication in the workshop is possible
Thermal insulation	
Added later with the facade construction	Integrated into the system component design
Component thickness	
Generally thicker due to separate material layers for each function	Generally thinner as functions overlap within the system component
Usable space	
Reduced due to greater component thickness	Increased due to lower component thickness
Additional requirements	
Less complex component coordination	Comprehensive component coordination (structural system, insulation, and sound insulation combined, etc.)
Planning scope	
Focus on structural planning	Comprehensive, integrated system planning required
Changes to the planning processes	
Conventional according to the SIA phase model	Significant changes compared to SIA phase model [31]
Production process	
On-site production of components and systems or prefabrication	Prefabrication of component elements or modules
Logistics	
Several smaller standard transports, material turnover on-site over a longer period	Fewer large or special transports; lower on-site material turnover over a shorter period
Construction Process	
Drying times and moisture ingress in on-site construction	Dry construction, on-/off-site accelerated construction
Maintenance	
Dependent on planning, documentation, and system separation	
Reuse	
Disassembly and reuse possible with appropriate planning and documentation	

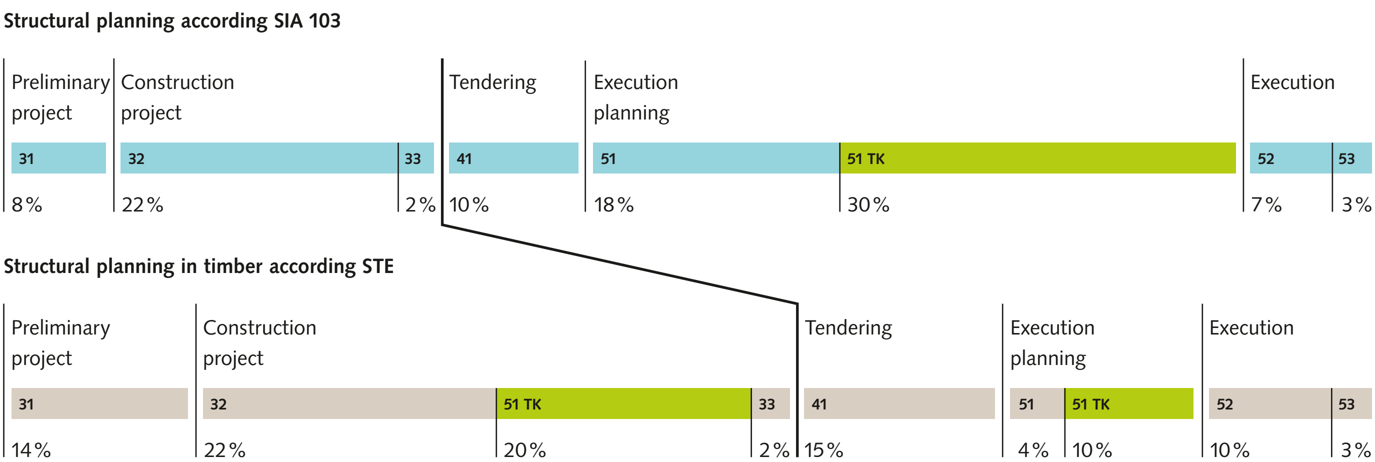
Figure 6
Overview of system logic based on STE Compact 01, eBKP-H, and SIA 2032 [31]

Functional layers according to eBKP-H
- C Structure
- E External cladding including insulation
- F Roof cladding including insulation
- G Internal cladding



Essential contents of project phases in timber construction
The system construction method in timber construction (off-site prefabrication) differs significantly from solid construction (on-site construction) in both planning and execution processes, leading to altered interfaces among project participants. Compared to the currently established SIA phases [31], timber construction shifts not only services and compensations, but also the timing of key decision-making milestones. This requires clients to make decisions earlier than they typically would in solid construction. Particularly in the phases of project planning, tendering, and execution, this results in a significant reallocation of the effort devoted to planning the load-bearing structure.

Figure 7
Phases and services in timber construction [31]



Structure
- SIA 103
- Timber
- Effort for planning the load-bearing structure

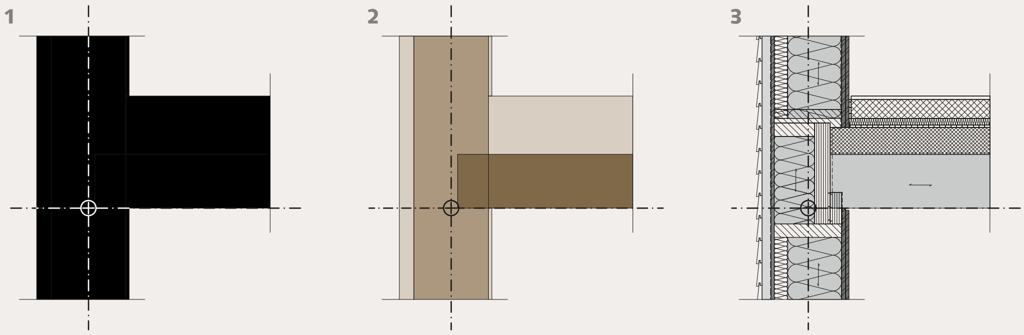
Phasen nach SIA 112:2014

31 Preliminary project
32 Construction project
33 Approval process
41 Tendering
51 Execution project
52 Execution
53 Commissioning
51 TK Execution planning for the load-bearing structure

Best Practice

Figure 8
Geometric planning stages of components

1 Solid-void plan with structural axes
2 Layer section with load-bearing and cladding layers
3 Construction detail with all building materials



Phase-appropriate levels of componen detailing
An excessively high level of detail in the early planning phases restricts design flexibility. A gradual and targeted development of the structural details helps to evolve the building as an integrated system.

Risks of premature detailing
There is a risk during early planning that generic component solutions and key details are introduced even before specific requirements are defined or verified. This can cause misunderstandings and limit the design flexibility needed for critical systems such as the structure or building envelope. It may also lead to essential requirement reviews and concept verifications being overlooked.

Clarity through graphical support
To counter this issue, the levels of detail or completion of component assemblies and key details should also be visually differentiated in the project workflow. This can be achieved by displaying only the necessary geometric information in each planning phase. In doing so, project partners receive only the relevant information. For example, this includes the layout of the structural layers and the cladding layers in construction details.

Regular communication
It has proven effective to briefly re-specify the objectives of the interaction each time component assemblies and key details are exchanged. As a central basis for understanding, the naming conventions of the components must be agreed upon and defined jointly by the project team. This targeted focus on relevant topics helps clarify critical interfaces at an early stage.

Axes as a common reference
Furthermore, the axes for all components should be defined and represented in models and plans. The axis grid serves as a common reference system and significantly simplifies collaboration between architecture and structural planning. It not only enhances communication but also enables the precise definition of construction details in the form of system nodes, as well as their classification based on recurring requirements. This creates the basis for efficient, model-based collaboration, which can be further optimized and potentially automated through the use of generative software (Object-Oriented Design Tools) such as Grasshopper and Dynamo.

Often, component variants are shared with specialists, for example, for cost estimation or ecological assessment. If corresponding adjustments are erroneously incorporated into a building model before a definitive decision is reached, it can lead to unnecessary additional effort and misunderstandings.

3.3.2 Machine-assisted production

The machine- and robot-assisted production of building elements and room modules is well established in Swiss timber construction and is growing as automation increases. This evolution creates specific demands regarding information requirements during the planning process and data quality at planning interfaces. The data used for machine-assisted production of timber buildings often differs significantly from that used in on-site construction projects. The level of detail in the information must be aligned with the degree of prefabrication and the chosen production methods.

3D models and planning tools for production

Work preparation, production, and assembly planning in timber construction are typically carried out using 3D models. When these models are enriched with additional data, they become specialized models that can generate lists and planning documents. The accuracy of the 3D model and the inclusion of tolerance considerations are crucial for production quality and straightforward assembly. Standardized connection details are often used between components, and these can be adjusted based on predefined parameters or rules. Moreover, 3D planning integrates optimizations to enhance the efficiency of producing linear and planar timber elements.

Automated plan and data production

For the automated creation of plans, lists, and machine data, software utilizes digital envelopes. As projects progress, these models can be augmented with further detail to meet the requirements of machine-assisted production. These models allow for various levels of detail to be represented:

- Complete building components, with functional designations for individual layers such as the structural framework and cladding.
- Individual building materials, including specific information about each material.
- Structured breakdowns, into elements or functional units (planning modules).

Planning lead time

To prevent conflicts and delays, it is recommended to allocate sufficient lead time at the beginning of the 3D planning process for orders and for providing all necessary information. The specific information required is project-dependent and should be clarified with the project team. A holistic, interdisciplinary approach to the design and planning process for prefabricated timber construction is essential.

Construction details and connections

In prefabricated timber construction, construction details and connections are critical since large-scale elements are prefabricated in production halls and then assembled on-site [15]. Specialized software can now generate and document parametric relationships even for complex connection details. However, this is often achieved using proprietary software without open data exchange formats. In many established BIM authoring tools, the parametric creation of details in a 3D model is still not fully advanced.

Data exchange between planning software

Current computer-aided design (CAD) software with IFC interfaces primarily focuses on the geometric and alphanumeric description of components. The digital editability of connections and construction details in the BIM authoring software commonly used in Switzerland is still very limited, offering few options for individual design. Moreover, the IFC format as an open data exchange schema does not support relational and typable elements for detailing. Additionally, IFC models often cannot be modified parametrically, as there are only a few authoring software solutions available based on IFC.

Reducing the number of construction details

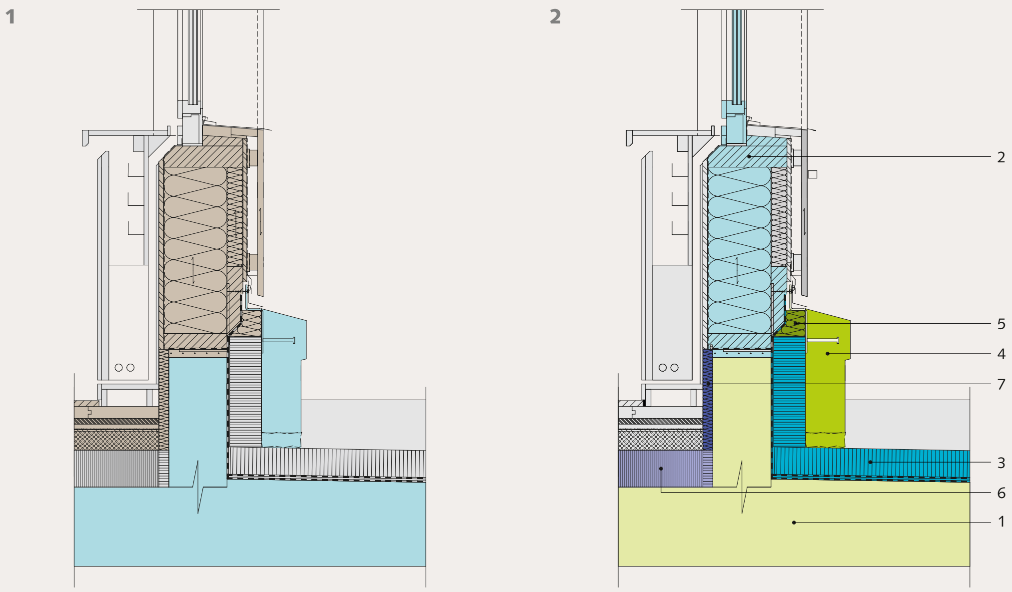
To efficiently prefabricate timber buildings, ensure high-quality assembly, and later enable easy disassembly, it is crucial to document, standardize, simplify, and precisely plan connection details throughout the project. The fewer the number of construction details, the lower the error rate, the higher the overall building quality, and the simpler the disassembly. This, in turn, positively impacts the reusability and residual value of the building.

Figure 9
Key details for clarifying the interfaces in planning

1 Trade interfaces
- Timber construction
- Solid construction
- Others

2 Assembly sequence
- 1. Foundation (Mason)
- 2. External wall element (Timber construction)
- 3. Flat roof and base insulation (Flat roof specialist)
- 4. Base cladding (Facade contractor)
- 5. Connection insulation (Plasterer)
- 6. Subfloor with insulation (Floor specialist)
- 7. Interior insulation (Floor specialist)

Best Practice



Interfaces, accuracy, tolerances and processes
The optimization of planning for machine-assisted prefabrication begins with clarifying the interfaces in the planning process. It is essential to define who provides which planning inputs and who is responsible for coordination.

Layer layout with trades and work steps
An initial structural outline that displays the layers can help project participants collaboratively determine who is planning which components and to what extent, as well as who coordinates what (i.e., the interfaces between trades). It is crucial to clarify the work steps dependent on the various trades and arrange them in the proper sequence (assembly order).
In a first step, simple key details can be sketched as layer layouts that, for example, distinguish between the functions of supporting, insulating (thermal, acoustic, etc.), and protecting (against weather, fire, etc.). Based on these sketches, all requirements present in the construction detail can be gathered and fundamental conceptual decisions can be made. For easier communication, the individual detailed plans can be embedded within building models (see Figure 26). Only once the designs are largely finalized should they be incorporated into digital building models.

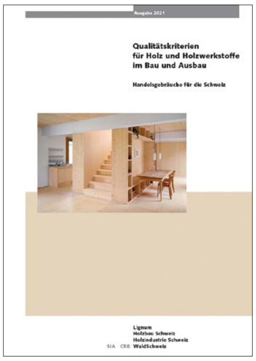
Interfaces with other construction methods
The layer layout can also specify which component layers are to be prefabricated and the required level of accuracy. Special attention must be paid to the interfaces with other construction methods, particularly on-site construction. Due to different tolerances, transitions, connections, and construction sequences must be planned in detail.

Coordination of water-bearing layers
Equally important in timber construction is the coordination of water-bearing layers—ensuring correct connections, overlaps, and adhesions—as well as clarifying the respective responsibilities, especially during construction and in the completed state.

Key details
Key details help visualize the allocation of trades and work steps. Throughout the entire project process, it is essential to monitor and ensure that the fundamental requirements—supporting, insulating (e.g., for heat and sound), and protecting (e.g., against weather or fire)—are met at all times, or at least are not permanently compromised during the construction phase.

3.3.3 Material supply chains and logistics

Figure 10
Quality criteria for wood and wood-based materials in construction and finishing—Trade practices for Switzerland [23]



Timber is locally available in Switzerland and is therefore ideal for sustainable and future-proof construction methods. Local value chains should also benefit from this resource. Forest composition varies, resulting in different mixtures of timber species and qualities from which various products can be made. Even though modern timber buildings largely consist of glued laminated timber (GLT), cross-laminated timber (CLT), and other wood-based materials, their production requires large quantities of standardized sawn timber products (e.g., beams or lamellas) in various qualities.

Early consideration of timber resources
Every construction project provides an opportunity to consider and optimally utilize different timber products and appearance classes [23] during the planning phase. This is particularly important when a building is intended to be constructed predominantly with in-house timber or timber sourced from the region. In such cases, procuring the material resources is a central aspect of the project. The availability, harvesting, and processing of the required timber must be planned, coordinated, and commissioned early to ensure that the material is available on time.

Standard dimensions
Planning takes into account the standard dimensions and formats defined in timber trade practices [23], ensuring that, in average-sized projects, there is typically no risk of supply chain bottlenecks. If planning is based on the provision of in-house timber and market-standard construction products—which in turn consist of standardized sawn timber products (lamellas)—the available round timber can be dimensioned even before the execution planning is finalized. Any additional requirements or surpluses can then be easily supplemented or sold on the market.

Timber procurement for major projects
For large construction projects with high demands for specific construction products, it is advisable to inform the relevant industry associations, potential manufacturers, or regional suppliers early on. Rough quantity estimates can now be easily derived from digital building models. For this purpose, both the configuration of the required structural components and the component catalog with the corresponding data must be available and approved. The structural planning must be sufficiently advanced so that orders for the required quantities of timber products, wood-based materials, and structural components can be reserved. Following this, the detailing phase integrates the construction details into the production model based on the reserved or pre-ordered standard formats, and the components are developed for manufacturing.

Figure 11
When a tree trunk is cut, different products are produced for material use.

Figure 12
Overview of dependencies and specification stages in timber construction project execution.

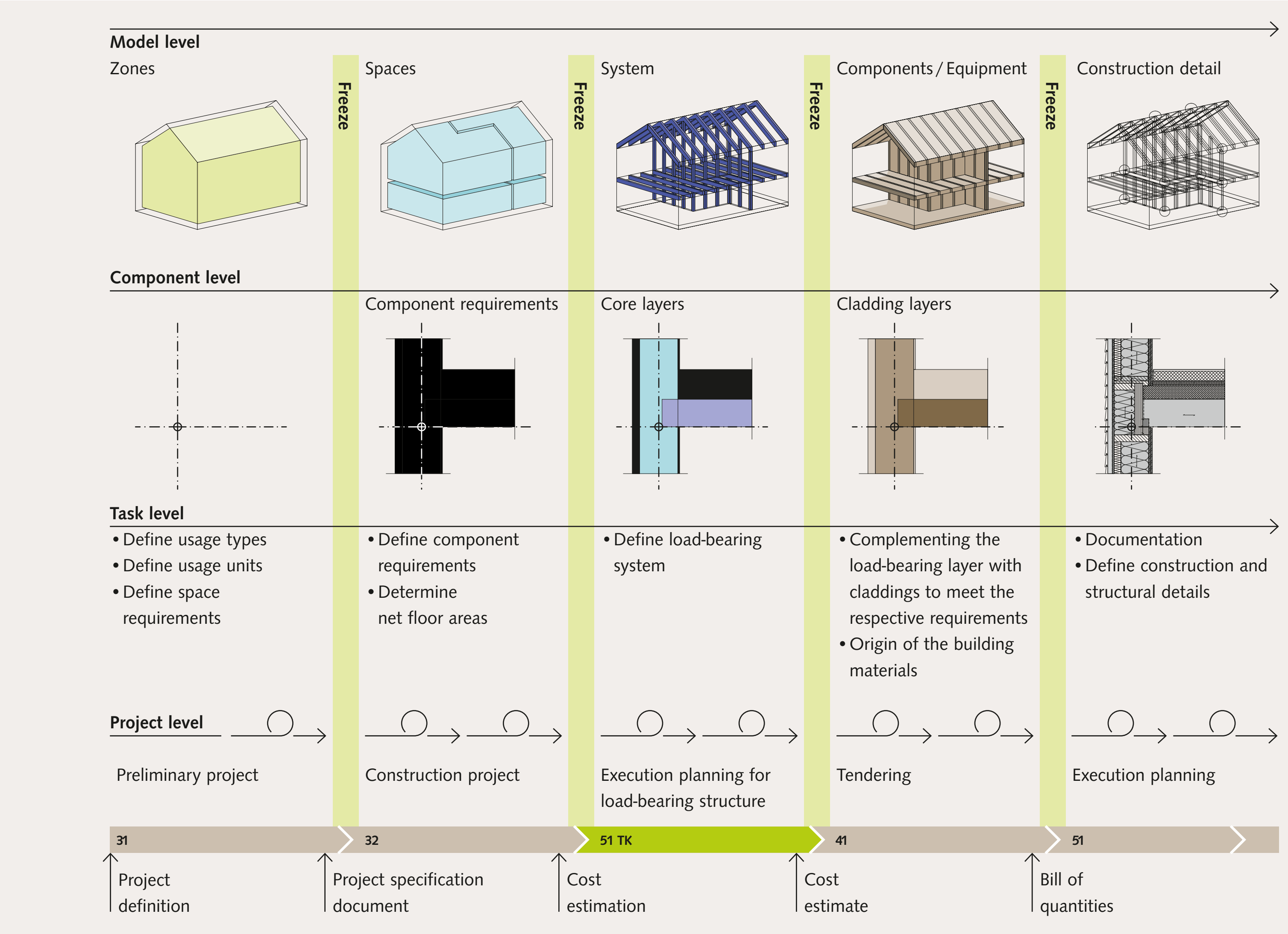
Best Practice

Dependencies and stages of completition in the project execution process
In the execution phase of a building project, primary usage requirements are typically established at the room and zone levels. These requirements provide the basis for developing systems composed of individual components that are seamlessly interconnected through carefully engineered construction details. This hierarchical approach not only addresses the building's functional needs but also ensures consistency and coherence across all systems and components.

Planning the planning
Operational and spatial requirements in buildings are the factors that allow components to be developed with regard to their specific needs, such as load-bearing function, insulation performance (thermal, acoustic), as well as protective functions (moisture, fire protection) [24]. From this, a logical sequence of processing steps can be derived, which serves as a framework for planning the planning process [15]: Zone and room requirements must be determined first, so that the corresponding component requirements can subsequently be derived. For example, components between usage units must meet different requirements than partition walls within usage units. The same applies to components on the building envelope compared to those within the building envelope.

From structural development to finished component
Starting from the zone, room, and component requirements, an integrated structure can be developed and the core layers of the components can be defined. This, in turn, forms the basis for the final definition of the respective component structures, including the cladding layers. This planning stage lays the foundation for the previously mentioned material reservation. Finally, the materials for the interior and exterior cladding are determined, and the construction details are finalized.

Planning as an iterative process in stages
It is important to recognize that planning progress is an iterative process, and new solution proposals always require a review of previously developed fundamentals. However, if project parameters that form the basis for project-specific solutions are changed, those solutions must be revised. For instance, if the perimeter of usage units or the requirements for rooms change, the resulting component structures and construction details must be updated accordingly.
Figure 12 suggests the latest possible deadlines for completing various planning steps, as they form the foundation for subsequent planning stages.


Model level
Zones
Spaces
System
Components / Equipment
Construction detail
Freeze
Freeze
Freeze
Freeze
Component level
Component requirements
Core layers
Cladding layers
Task level
• Define usage types
• Define usage units
• Define space requirements
• Define component requirements
• Determine net floor areas
• Define load-bearing system
• Complementing the load-bearing layer with claddings to meet the respective requirements
• Origin of the building materials
• Documentation
• Define construction and structural details
Project level
Preliminary project
Construction project
Execution planning for load-bearing structure
Tendering
Execution planning
31
32
51 TK
41
51
Project definition
Project specification document
Cost estimation
Cost estimate
Bill of quantities

4 Basics of the BIM working method

In the previous chapter, the peculiarities of the processes in the planning and execution of timber construction were explained, which are already highly digitized and networked. This chapter will now explain the fundamentals of translating these processes into the BIM working method. To effectively participate in projects using the BIM working method, it is initially important to understand the BIM competency maturity of the operational BIM project partners, in order to derive appropriate objectives and stage-specific requirements. In SN EN ISO 19650-1 [40], the ‹BIM Maturity Levels› 1–3 are differentiated [13].

The stage plan from buildingSMART Switzerland even divides it into five levels (0–4) [1], with each level building on the previous one.

4.1 BIM-Status assessment and communication

Table 2
Competence levels in the BIM working method

Level	Definition of levels according to buildingSMART Switzerland [1]
Level 0	Refers to a working method in which no common, digitally structured data models are used, and information is predominantly exchanged in analog form or via image files.
Level 1	represents the use of BIM models by individual participants, while the results are still exchanged conventionally (‹LittleBIM›). It combines 2D-CAD planning with 3D models as the standard for planning construction projects using national and company-specific standards. This stage requires the knowledge to utilize the appropriate digital tools within one's own area.
Level 2	The consistent application of the SN EN ISO 19650 series aims for the seamless implementation of information management processes and national specifications, as well as the use of integrated information models as complete representations of buildings (PIM, AIM [6]). These complete models consist of several discipline-specific models. Collaboration at this stage is based on centrally shared data models for the project team (‹BigBIM›), with exchanges conducted manually—meaning there is no automation for reconciliation or data processing. This level of collaboration demands that all parties agree on common definitions for information structuring, requiring a shift in the collaboration culture, including the coordination of shared information structures and legal frameworks for model-based collaboration.
Level 3	Consistent implementation of ‹OpenBIM› as the standard in construction planning. The integrated, model-based collaboration method enables automated processes and achieves true digital interoperability. It requires the continuous use of standardized information structures and data schemas, as well as the deployment of appropriate technology as the foundation for digital integration in collaboration.
Level 4	Currently the highest achievable stage, Stage 4 is characterized by the interconnection of communicating systems that bridge the physical and virtual worlds. This includes the Internet of Things (IoT) and cyber-physical systems (CPS) such as machine control, sensor technology, and real-time monitoring. Achieving this stage requires the complete integration of standardized information structures and data schemas, along with a suitable infrastructure to support the inclusion of communicating systems.

Experience counts
To collaborate successfully across disciplines in a project using a shared data model for building information (BigBIM), practical experience with digital data processing methods and their implementation in BIM models within one's own field (LittleBIM) is essential. Initial, straightforward use cases are crucial for learning the data-driven approach. In this context, the deployment of digital building models with clearly defined objectives should be tested. This enables the accumulation of early experiences with the BIM working method and the definition of individual interfaces.

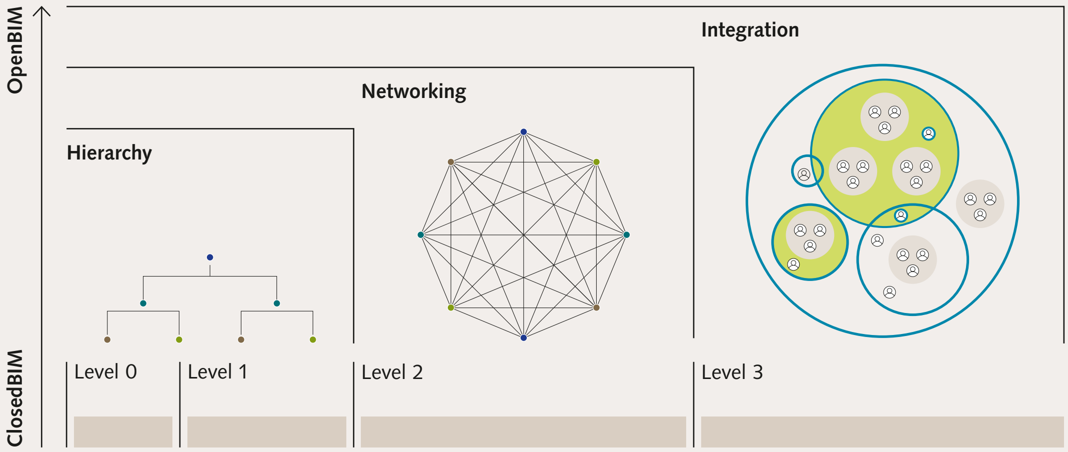
Technical language and common understanding
To achieve integrated, data model–based collaboration and to fully exploit the potential of digital tools and methods in the construction industry, a common technical language is essential. This requires the use of standardized terminology with clear definitions and explanations for the specific concepts of the BIM working method.
The numerous abbreviations in BIM technical language can often be intimidating for newcomers, and even experienced professionals encounter challenges. For this purpose, buildingSMART Switzerland has developed a national glossary [5]. It is expressly advised not to translate abbreviations into German or to use terms that are defined in national standards or docu-

mentation from other countries, which lack both international and Swiss validity. For example, the term ‹Client Information Requirement› (AIA) as found in VDI 2552 sheet 10 is neither recognized internationally nor in Switzerland, and therefore should not be used. Instead, both in Switzerland and internationally, the term ‹Exchange Information Requirements (EIR)› is used.

Best Practice

Figure 13:
ClosedBIM and OpenBIM in relation to the BIM competence levels according to buildingSMART Switzerland

Comprehensive BIM deployment has an impact on collaboration methods and formes of organization



The BIM method is often confused with pure 3D planning. In reality, it is a digitally supported data and information management approach for project execution in construction. This is accompanied by a cultural shift in collaboration:
Instead of ‹***I'll just send you what I have, in whatever format is easiest for me, and you can pick out what you actually need,***› the new principle is: ‹***We first agree on what information we need from each other, in what format, and how we will designate the data. Then, we exchange only the truly relevant data. The guiding principle is: as much as necessary, but as little as possible.***›
This reduces the effort required for data preparation and interpretation, lowers error rates, and allows work to build directly upon the exchanged information. The necessary competencies for this type of collaboration must be developed gradually, with the stage plan from buildingSMART Switzerland [1] providing a solid foundation.

Examples of gradual competency development based on the buildingSMART Switzerland stage plan [1]:

Level 1: Internal use of data from the model
- Generation of element lists: windows, doors, and rooms
- Extracting material information from the model
- Recognizing and communicating data needs

Stage 2: Exchange of structured data on common goals and project-specific outputs
- Execution planning based on 2D data from production and workshop planning that includes only the relevant elements
- Correct implementation of naming conventions and data filing
- Structural model with exclusion zones as the basis for the conceptual model of the vertical and horizontal distribution of technical building equipment (HVACSE)

Stage 3: Exchange of structured data and automation of processes based on this
- Application of conventions for data structure, designation and process handling
- Use of digital and machine-readable data for production, interface solution from CAD to CAM
- Control and quality check of data models including reporting
- Automated collision check of specialist models based on predefined rules and output of reports
- Cross-disciplinary and cross-process use of data through compliance with conventions and interoperability of digital tools (software)

4.2 Foundations for Communication

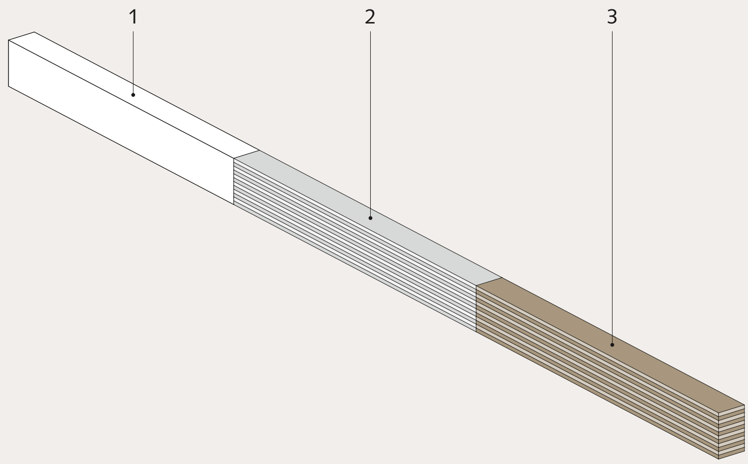
In this section, only the minimal foundations necessary for communication in the BIM working method are listed and explained. The currently most important foundational documents include:

- the execution models from SIA and buildingSMART Switzerland for the SN EN ISO 19650 series
- the definition of use cases according to SN EN ISO and buildingSMART Switzerland
- the formulation of the information requirements (LOIN) according to SIA and buildingSMART Switzerland
- the buildingSMART Data Dictionary (bSDD), which complies with the standards SN EN ISO 12006-2 [38] and -3 [39] as well as SN EN ISO 23386 [48] follows. By linking different dictionaries and classifications, it creates a common ontology in construction that is also crucial for the precise application of artificial intelligence.

Best Practice

Figure 14
Digital continuity from the generic instance to the specific product

From the generic instance to the specific product



1 Beam (IFC Entity)
dictionary: IFC
ifcBeam (UID: 7f07946e-f8d2-4f0f-a25c-5bae7d67f92a)
Properties (generic property): –
Requirements from planning
Bending strength (text attribute)
Dimensions
Width (numeric attribute) 140 (Value)
Height (numeric attribute) 240 (Value)
Unit mm
Load-bearing (text attribute)

2 Glued laminated timber (IFC Material)
industry dictionary for products in wood
(UID: 2f378f89-a39c-4b17-89dc-09249073d6a8)
> each property has a permanent link in the bSDD
Properties (Class Property): –
Material specifications according to building product standard
Wood type
Commercial form
Strength

3 Glulam beam (Digital Product Pass)
GTIN code (Article number)
Digital Product Pass DPP
according to industry dictionary for products in wood
(UID:a378f9ba-3a9c-4b17-89dc-c0924907b368)
> each property has a permanent link in the bSDD
Properties (specific property):
digitalproduct declaration / data sheet
Wood type
Commercial form
Strength

Information is contextualized data
For example, the following text: *‹**A glued laminated timber beam in accordance with SN EN 14080 with a width of 140 mm**›* consists of parallel layers of information, as shown in Figure 14. These layers ensure information continuity for this component throughout the entire lifecycle of a building—from its development to its deconstruction. By maintaining parallel documentation of component information at different information levels or degrees of detail, the lifespan of the component can be extended beyond that of the building, and the processing of the necessary information can be made as efficient as possible. In order for the relevant information to be available at every phase of a building's or component's lifecycle, the respective data must be placed in the appropriate

Specialist knowledge
Competence to develop and interpret technical data and information models. It is often also informal knowledge based on networked information.

Knowledge
Cross-linked information: 30/50 mm is a standard batten dimension

Information on
Contextualized data: 30/50 mm batten dimension

Data
Entity: Wood batten **Attribute:** • **Property**: Width – **Value**: 30 – **Unit**: mm • **Property**: Height **Value**: 50 **Unit**: mm

context; that is, logically grouped into processable information through information layers. To structure data so that it serves as meaningful information about buildings and their development, construction, and operation, various functional units (entities) within a building are first clearly distinguished from one another. They represent different physical or functional components of a building, such as rooms, walls, doors, ventilation systems, or structural frameworks.

Each of these entities is described using attributes with alphanumeric properties:

1. Numerical (numbers)
- Quantitative attributes represented as numbers with associated units.
  These refer to measurable characteristics of an entity and have specific values and units (e.g., height = 3 m).

2. Textual (letters)
- Qualitative attributes represented as text, describing aspects such as function, composition, or physical characteristics.
  These provide descriptive information without measurable units (e.g., class A, color = ‹red›, manufacturer = ‹Company X›).

Through this structured method of data description, information can be precisely contextualized and organized, enabling a detailed description and efficient management of construction project data—from a generic description of requirements to a specific definition of services. This, in turn, allows for the structured evaluation of building-related experiences and their integration into expert knowledge. Based on established knowledge, information is made machine-readable using standardized data structures, allowing it to be transferred and processed. These very fundamentals form the basis of SN EN ISO 19650 for information management, upon which the execution models from buildingSMART Switzerland [2] and SIA [29] are built, as well as the IFC data schema [33] and the buildingSMART Data Dictionary (bSDD) [55] from buildingSMART International, which will be discussed in Chapter 4.6.

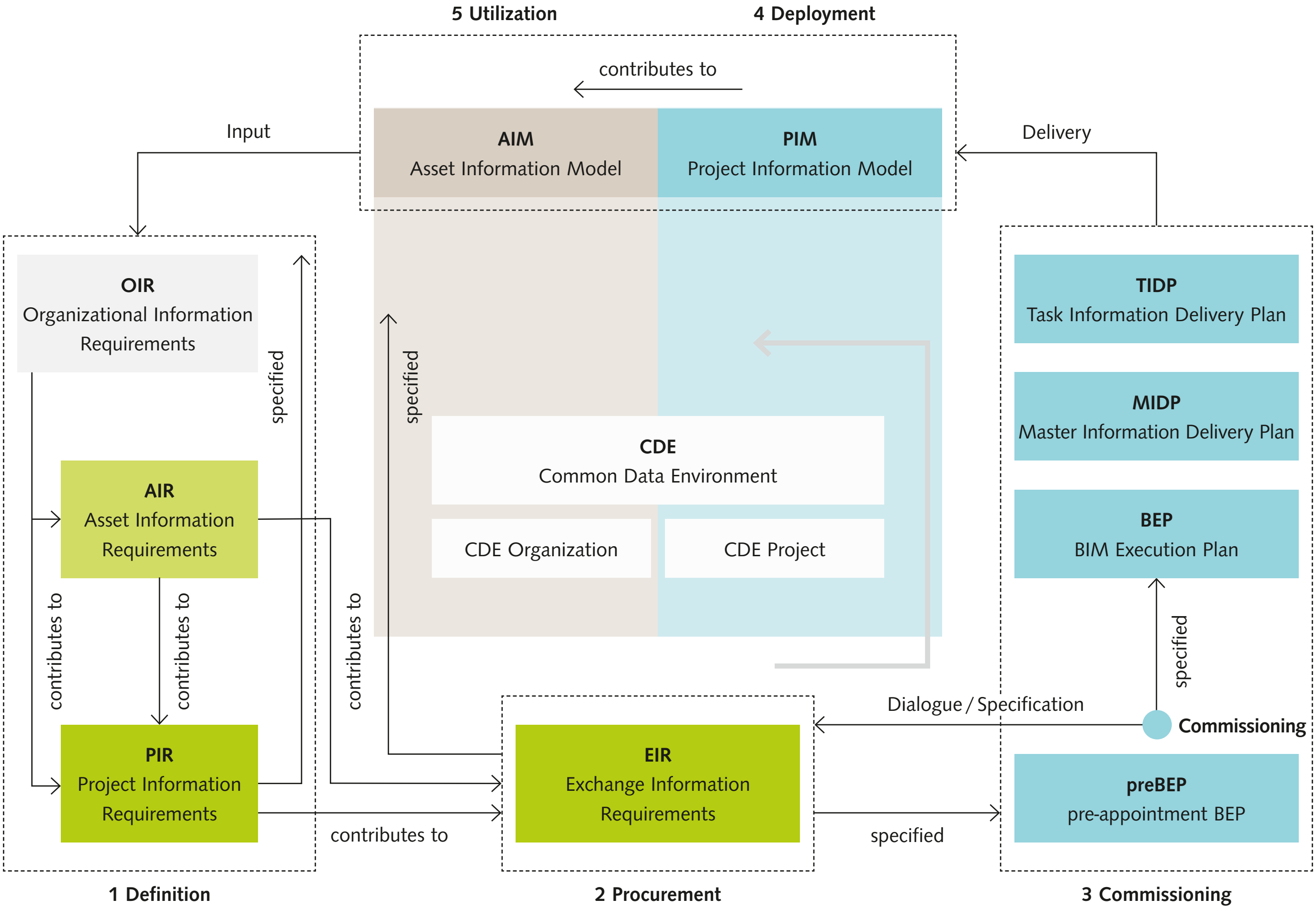


Figure 15
BIM processing model [3]

Client
Organizational level
Management level
Design level

Contractor
Design level

Operator
Management level

Introduction of the SN EN ISO 19650 series of standard-in Switzerland
Since 2019, the SN EN ISO 19650 [38] ... [45] has been part of the Swiss standard framework for applying the BIM method. Currently, SIA is developing the guideline SIA 4007 for the implementation of this series in Switzerland.
The SN EN ISO 19650 series outlines information management throughout the entire lifecycle of a building. It is consolidated in the execution models of SIA [28] and buildingSMART Switzerland [3] and covers not only the design and planning phases but also governs the continuous flow of information throughout the lifecycle of a building (asset). Special emphasis is placed on the handover of building information from the delivery phase to the operational phase. The series provides recommendations for managing information, including its exchange, recording, versioning, and organization for all stakeholders. It does not prescribe the form of information description or structuring—meaning it does not define whether and when 3D models must be used—but rather describes how the provision and flow of information for buildings should be planned and coordinated.

SN EN ISO 19650-1 Concepts and principles [40]
This document explains how building information should be described and managed. It focuses on how information should be provided in line with specific goals or requirements, distinguishing various roles such as information requester and provider. The planning for information delivery described in the standard also covers how different types of information—such as documents or digital models—and their structures must be defined, as well as how these pieces of information should be coordinated and integrated.

SN EN ISO 19650-2 Delivery phase of the assets [41]
This document describes how information should be managed during the delivery phase and how the exchange of information occurs during a building's delivery phase. It provides detailed guidance for the planning and realization phases, explaining how the BIM Execution Plan (BEP) is used and how to handle project platforms as a Common Data Environment (CDE).

SN EN ISO 19650-3 Operational phase of the assets [42]
This document outlines the requirements for information management during the operational phase of buildings. It also describes the interfaces between the realization phase and the operational phase. At its core is the Asset Information Model (AIM), which serves as the digital building documentation. BuildingSMART Switzerland has published the application guide ‹Asset Information Model (AIM)—Basics› for the standard [6] published.

SN EN ISO 19650-4 Information exchange [43]
ISO 19650-4 provides a specification for information quality and sustainability applicable to every exchange of information. It distinguishes between a ‹must› requirement for information delivery and a ‹should be considered› recommendation for information delivery. The document is intended to support collaboration via project platforms (CDE, Common Data Environment) and sets out the criteria for selecting standards and technical solutions. Continuous and high-quality information models should lead to better planning and execution outcomes and offer an optimal foundation for the long-term use of buildings.

SN EN ISO 19650-5 Security-minded approach to information management› [44]
This document specifies the principles and requirements for a security-conscious management of sensitive information. It provides a framework to identify significant vulnerabilities and to establish the necessary controls for managing security risks.

SN EN ISO 19650-6 Health and safety information [45]
This part is currently under development by TC 442 of CEN (European Committee for Standardization).

4.3 Target specification and information requirements

In current concepts [4] and research findings [15], the importance of goal formulation at the beginning of a project is emphasized. Moreover, due to the complexity of construction projects today, no stakeholder can independently and conclusively define project goals. To ensure that all parties understand and implement the goals, they must be examined, reviewed, refined, and coordinated from various disciplinary perspectives. The targeted goals should be established as measurable target values (metrics). These metrics form the basis for developing and implementing optimized buildings, as well as for regular progress monitoring. All stakeholders are responsible for continuously reviewing their respective areas of expertise and reporting any deviations. Efficient information management—based on standardized data structures and information models—is critical for this process.

The benefits of BIM in project execution
Digital building models serve as shared information platforms in the BIM working method; they create transparency and enhance effectiveness and productivity in collaboration [14]. However, the BIM method should never be an end in itself; it must always be applied with the project goals in mind. To achieve this, parallel planning processes must be coordinated and interdisciplinary solutions developed. Successful collaboration requires that all relevant project participants are identified early and work together to clearly define interfaces and effectively achieve project goals.

Information management and documentation of buildings
The SN EN ISO 19650 sseries distinguishes two key phases in the management and documentation of building information, each associated with a specific model:

- The project information model (PIM): Covers the delivery phase, which includes the planning, realization, and commissioning of a building.
- The asset information model (AIM): Covers the operational phase, which includes the use, operation, and maintenance of a building. The AIM serves as the digital documentation of the building and must always reflect its current state, necessitating continuous updates.

Clarification and definition of project goals
Typically, some project goals are already defined and documented by the client during the project definition phase. In the initial project workshops, the planners should clarify the project definition with the client and document it along with additional technical specifications in the project specification document. Moreover, target values for these specifications should be set, including the methods for measurement and verification. For successful project execution, it is crucial that all project participants understand and jointly pursue the defined goals.

Best Practice

Table 3
Formulation of objectives at various project levels

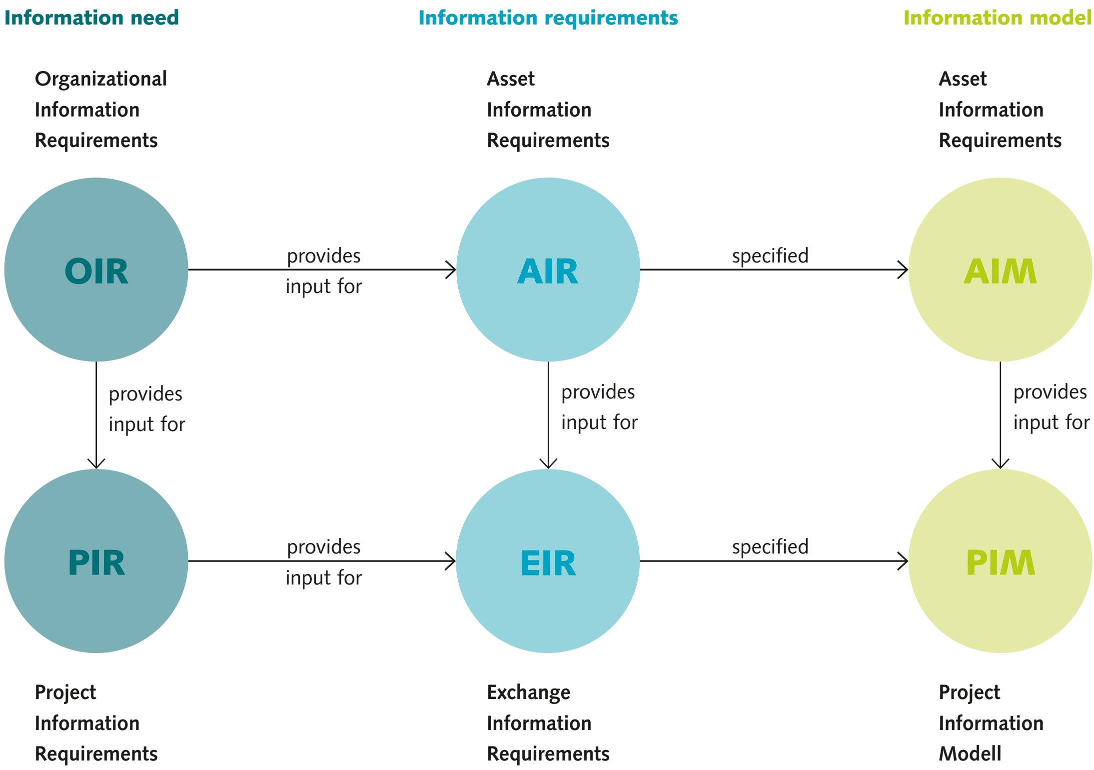
Target level	Description	Basis or aid
order Client and project objectives	**Why & what** Communication and consolidation	OIR, AIR, PIR = EIR & preBEP
Strategic—Milestones Planning and production targets	**When** Project-specific process planning, quality assurance frameworks, and progress monitoring.	Pull planning according to BIMwood, phase models & planning of the planning in the project team = BEP milestone plan
Coordinative—Specialist coordination Measures and BIM applications	**How** Project-specific coordination frameworks, grids, and tools; quality assurance and development measures	Use Case Management buildingSMART, service specifications & communication within the project team = BEP coordination plan & BEP model plan
Operational—disciplinary Activities and responsibilities	**Who in what form** Definition or agreement on outputs per discipline, as well as the necessary inputs, including their form and quality.	T-model according to BIMwood & discipline-specific communication within the project team = BEP roles and responsibilities & BEP model plan

Structure of information requirements and models
The two information models mentioned above (PIM and AIM) contain both geometric and alphanumeric information as well as additional project documentation. The provision of information is differentiated into three levels from the perspective of the information provider and divided into the two construction completion levels ‹project› and ‹object›:

- the need for information
  - OIR ‹Organizational Information Requirements›
  - PIR ‹Project Information Requirements›
- the information request
  - AIR ‹Asset Information Requirements›
  - EIR ‹Exchange Information Requirements›
- the information model
  - AIM ‹Asset Information Model› = the overall model for building documentation
  - PIM ‹Project Information Model› = the overall model of the project

This structure enables clear separation and management of information needs and requirements for both the project and the building's long-term operation. Organizational Information Requirements (OIRs) are derived from the information provider's overarching organizational objectives, while Project Information Requirements (PIRs) stem from specific project goals. From these, Asset Information Requirements (AIRs) are established from an operational perspective, and Employer's Information Requirements (EIRs) are formulated based on both project management and operational viewpoints. The client's overarching project objectives form the foundation for the project-specific documentation requirements for the Asset Information Model (AIM) and the Project Information Model (PIM). These models, in turn, define the BIM project execution objectives, ensuring alignment with the project's broader goals and overall information management strategy.

Figure
Provision of information [13]



Coordination of the EIR and preparation of the preBEP
For BIM-based project execution, the Exchange Information Requirements (EIR) serve as a foundational element. Together with general project information, milestones, the client's specifications regarding applicable standards and use cases, as well as the definition of organizational levels and service specifications with their required information depth (LOIN), the EIR is coordinated within the preBEP (preliminary BIM Execution Plan). The preBEP forms the basis for tendering and the engagement of the project team (delivery team) and should be established as part of the contractual agreements.

Development and adaptation of the BIM execution plan
Building on the preBEP, the project team finalizes the BIM Execution Plan (BEP), which outlines how information is managed throughout the project lifecycle using effective information management practices. This living document serves as a practical guideline for BIM-based collaboration, detailing:

- Organizational structures, roles, and responsibilities.
- Collaboration processes and interfaces
- Methods of information delivery, including models and documents.
- Protocols for information exchange, such as the use of a Common Data Environment (CDE).

Before each project phase, the BEP must thoroughly detail all aspects of collaboration. Consequently, it needs to be continuously updated and should be treated as a deliverable from the delivery team rather than a fixed contractual element.

Best Practice

The preBEP and BEP in Practice
The terms **preBEP** (pre-appointment BIM Execution Plan) and **BEP** (BIM Execution Plan) originate from the international standard series **SN EN ISO 19650**, which is published in English. Familiarity with these terms and their precise meanings is essential for effective communication among all stakeholders in a construction project.
Given Switzerland's multilingual context, the use of English abbreviations (preBEP and BEP) has been standardized in norms, standards, and documents. However, in German-speaking regions, the term **BAP** in German ‹BIM-Abwicklungsplan› is also common. While this is accepted locally, the correct usage of **preBEP** and **BEP** should be prioritized for consistency in international and cross-disciplinary projects.
Currently, the preBEP and BEP are often combined into a single document for practical reasons. In such cases, it is critical to clearly differentiate:

- **Contractual content:** Sections that are part of the contract and can only be modified through formal amendments.
- **Project team agreements:** Sections related to the internal organization and management of the delivery team.

For more guidance, refer to the contract principles for BIM detailed in Chapter 5.1.

4.4 Use cases and depth of information requirements

With our growing understanding of the environment, its functioning, and its finite resources, the criteria and requirements for buildings are evolving. Buildings should now be designed and operated to minimize environmental impact, consume fewer resources, provide a long service life, and offer flexible usage options. The increasing technical complexity of modern buildings, combined with rising demands, requires new approaches: buildings must be calculated and optimized differently during the planning phase and carefully documented for operational purposes. For simple structures, a standardized tech-nical guideline such as SIA 400—Plan Processing in Building Construction [35] is sufficient to regulate their graphical repre-sentation, including hatch patterns and presentation forms for each planning phase. However, this guideline is no longer adequate for the documentation of timber constructions. To address this, the Swiss Timber Engineers (STE) association developed standardized graphic representations specifically for timber construction, compiled in the document Compact 02—Plan Representation in Timber Construction. [32] This supplement expands the existing generic standards for plan repre-sentation by incorporating the specific requirements of timber construction, ensuring a higher degree of precision and relevance for this application.

Measurable sub-objectives as a basis for the level of information need (LOIN)

Digital tools and methods now enable us to plan buildings as complex systems through calculations, simulations, and com-prehensive information management. This allows for more detailed design and holistic optimization than was possible with analog tools and methods. However, standardized plan presentations and service descriptions alone are no longer sufficient to meet these demands. To achieve project objectives, specific measurable sub-goals must be defined and continuously refined throughout the project. These sub-goals require targeted actions, which are best formulated as use cases:

- Information requests should always be made with a clear purpose and application in mind.
- The formulation and application of use cases has proven to be an effective method for achieving clarity and precision.
- A use case defines the goal and purpose of information processing and includes a process description, along with specific Exchange Information Requirements (EIR) to achieve the associated objectives.

From these use cases, the required Level of Information Need (LOIN)—including geometry, alphanumeric data, and documentation—is derived. Each use case determines the why, when, who, and what of the information exchange, ensuring a structured and purpose-driven approach to project execution.

Best Practice

Determining the level of information required (LOIN) in two steps

Step 1:
Definition of the use case (prerequisite)

For a needs-based definition of the ‹Level of Information Need› (LOIN) in accordance with EN 17412-1 [37] the required objectives must first be defined. These objectives form the basis for the information supply requirements, but are not themselves part of LOIN.

Why
Purpose and intended use These specify the use case and the use of the information.
When
Milestone Information delivery Time at which a specific delivery object is expected
Who
Actors in the project This includes both the recipients of the information (information consumers) as well as the information creators (information suppliers).
What
Information content The required information is defined in a specific information requirement depth, the ‹Level of Information Need› (LOIN).

Step 2:
Definition of the required level of information (LOIN) for geometry, alphanumerics and documentation

How
1. Geometry Includes the definition of detailing, dimension, position (localization), visual appearance and parametrics. The document ‹Level of Information Need Building Construction | Application, 2024› from buildingSMART Switzerland provides guidance in this regard.
2. Alphanumerics Unique identifiers (e.g. ID) are defined here (e.g. from the bSDD) and the required properties are defined as attributes and values.
3. Documentation Determination of delivery results and delivery forms at a specific point in time
Overarching responsibilities for the definition of levels of detail and delivery forms
Buyer Defines delivery results in terms of their form and content from an operational and organizational perspective [6]
Provider Creates delivery results based on current technical principles and standards
Cooperation Technical standards, along with operational and organizational requirements, should be harmonized to establish a project-specific Level of Information Need (LOIN) for various milestones throughout project execution and handover.

Use of information platforms for LOIN information requirements

According to the standard SN EN 17412-1 ‹Level of Information Need› (LOIN) [37] a detailed description of the level of information need is required to determine the development status of a project and its products and to organize the exchange of information between different stakeholders. Practice has shown that it is neither expedient nor efficient if the organizations and project teams involved only ever develop the LOIN information requirements for themselves. For this reason, platforms such as the Use Case Management Service from buildingSMART International [53] or the ‹BIM profile server› from crb [54] have been created. These described use cases with specific information requirements for each project phase that have proven themselves in practice (best practice).

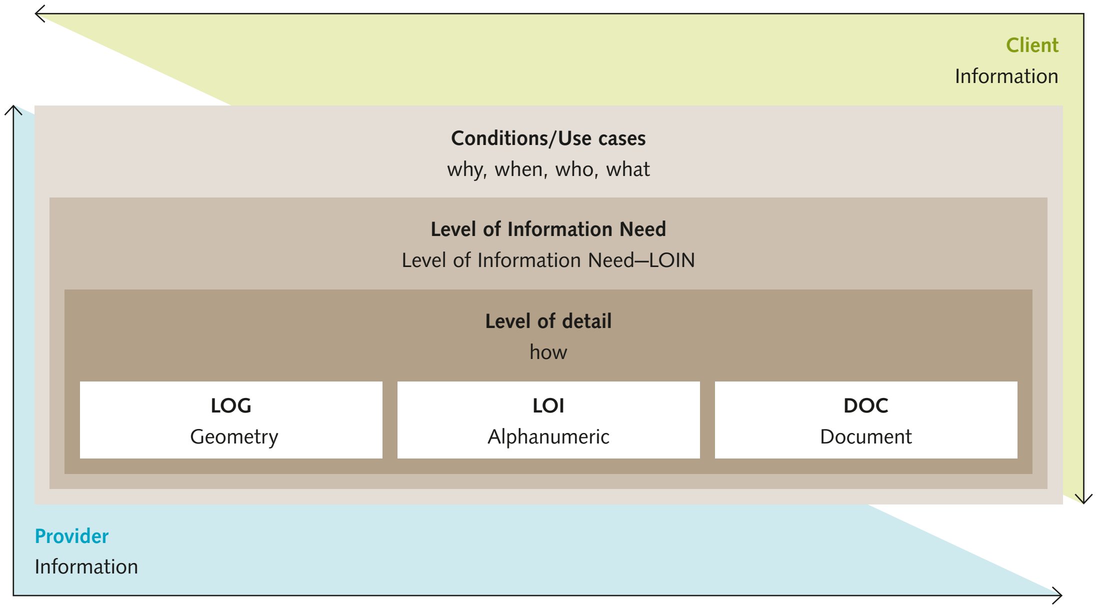
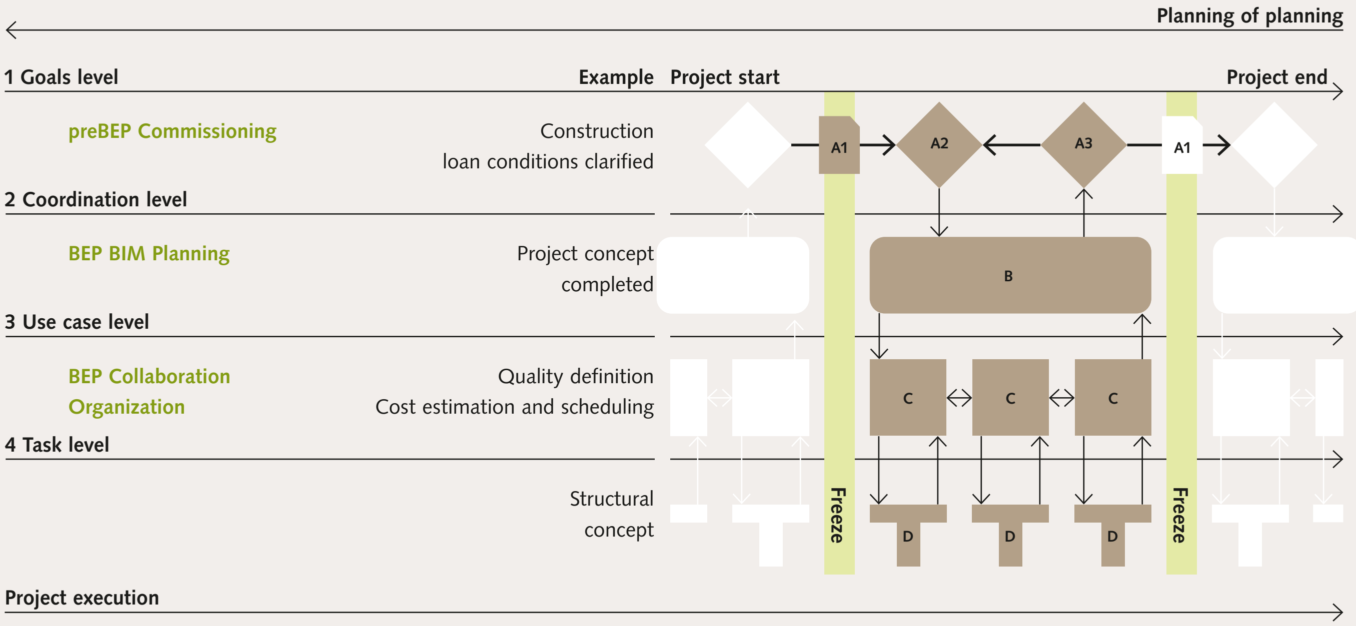


Figure 17
Overview of the LOIN information structure

These platforms provide organizations, clients and project teams with an overview of proven use cases. The use cases relevant to the respective project and their exchange information requirements can be compiled in the EIR. In this way, the information requirement levels (LOIN) and the levels of detail (LOG, LOI, DOC) can be applied effectively on the basis of proven applications. A BIM use case describes the specific use of a digital building information model (BIM model) to achieve a defined goal in the construction process. It involves the specific implementation of a work step or process using the BIM method. Typical use cases include plan derivations, collision checks or the use of the model for calculations that contribute to achieving the measurable sub-goals and optimizing the construction process.

Best Practice

Structured derivation of exchange information requirements (EIR) from project objectives



A1 Goals per milestone
A2 Fundamentals and requirements
A3 Developed outcome (fundamentals and requirements for further project phases
B Sub-goals
C Use cases
D Task description, technical sub-tasks as information delivery packages

Creating exchange information requirements (EIR) from asset and project information requirements (AIR and PIR) can become very complex and confusing, especially if they are not derived from clearly defined objectives or use cases. Experience to date also shows that far more than just alphanumeric information is required for the provision and operation of buildings. To simplify the definition of project-specific use cases, these should be derived directly from the defined project objectives and planned backwards from the final project completion using the pull planning method.

A distinction should be made between the following levels in the project execution process [15]:

1. Target level:
Defines the milestones and ensures that the results achieved are passed on to the next sub-goal

2. Coordination level
Defines sub-goals as work packages, coordinates disciplinary delivery objects across disciplines and monitors progress

3. Use case level:
Describes the delivery objects required for the sub-goals as use cases and names of the actors involved.

4. Task level
Derives the individual work steps of the various disciplines from the delivery objects and describes them

Coordination of parallel processes

In construction projects, certain processes inherently run in parallel. It is crucial to coordinate these processes and integrate their results into a functioning overall system. This requires iterative alignment and verification against the project objectives. The coordination level serves as a framework for managing this complexity. Coordination packages can, for instance, be based on the SIA 112 Construction Planning Model [34] (currently under revision). Generic service packages such as strategic planning, feasibility studies, conceptual design, and solution development can also be used as a foundation for organizing tasks.

Figure 18
Levels of project management with digital building data models based on BIMwood [15]

Best Practice

The T-model as a working aid

In the project ‹BIMwood›, the ‹T-model› [15] was developed as a tool to visualize the dependencies between information delivery packages at the task level. This framework offers a structured overview of the expected inputs and outputs of the information packages, linking them in the proper sequence for effective project execution. In timber construction, specific tasks, their dependencies and levels of detail can be described in the T-model. As shown in Figure 12, these tasks can be mapped onto a grid and arranged in an ideal sequence at the use-case level in relation to the project objectives, ensuring that they build logically on one another and optimally support goal achievement. The outcome of the coordination packages then serves as the starting point at the objectives level for the next use case.

Sub-task: Structural concept		
Fundamentals	**Work steps**	**Results**
• Architectural concept • Building services concept • Live loads and serviceability	• Work steps • Load assumption • Component and structural analysis	• Position plan • Basic bracing concept • Key interfaces and connections

Figure 19
Task grid T-model according to BIMwood as a basis for coordination [15]

Cooperation and transparency in the project team

A fundamental aspect of the project execution framework, as also noted by BIMwood [15], is the inclusion of all project participants as active members of the team—from clients and providers (designers and contractors) to user representatives and operators. Collaboration across all process levels is crucial for establishing a shared basis of understanding and transparency. Digital tools can be employed not only to monitor progress toward the defined goals but also to visualize technical issues and facilitate clearer communication. This approach not only enhances efficiency for all involved but also improves the overall quality of the project.

4.5 Processing of exchange information requests

The Level of Information Need (LOIN) for each use case encompasses the required level of detail across three key dimensions:
- Geometry (LOG): The required level of geometric detail.
- Alphanumerics (LOI): The necessary level of non-graphical, data-related detail.
- Documentation (DOC): The required supporting documents and metadata.

The LOIN can be structured based on the IFC data schema developed by buildingSMART International. This schema is specifically designed to facilitate software-independent information exchange within construction projects. By being independent of native, software-specific file formats, the IFC schema enables efficient, cross-platform exchange of information, ensuring seamless collaboration across various tools and disciplines.

Information Delivery Specification (IDS)

buildingSMART International has developed the Information Delivery Specification (IDS) as a machine-readable standard for the precise and efficient handling of model-related, alphanumeric information requirements. [57] The IDS is based on the Industry Foundation Classes (IFC) data schema, which supports software-independent, interdisciplinary collaboration in BIM projects (OpenBIM). The IDS enables the conversion of alphanumeric exchange information requirements into a machine-readable format. This specification can be directly imported into authoring tools like CAD software or checking tools such as Modelchecker, facilitating project workflows and quality control. The IDS format specifies how objects, classifications, and properties (e.g., attributes and values with units) must be described and structured. Instead of manually entering information into software, the IDS allows the automatic generation and import of:
- Properties to be delivered.
- Their names and value ranges.
- Assignments to classifications and property sets.

By utilizing an IDS file, the corresponding data fields are automatically created in the correct locations, filled in as needed, and exported for further use. This automation streamlines the information management process, significantly reducing errors and improving quality assurance throughout the project lifecycle.

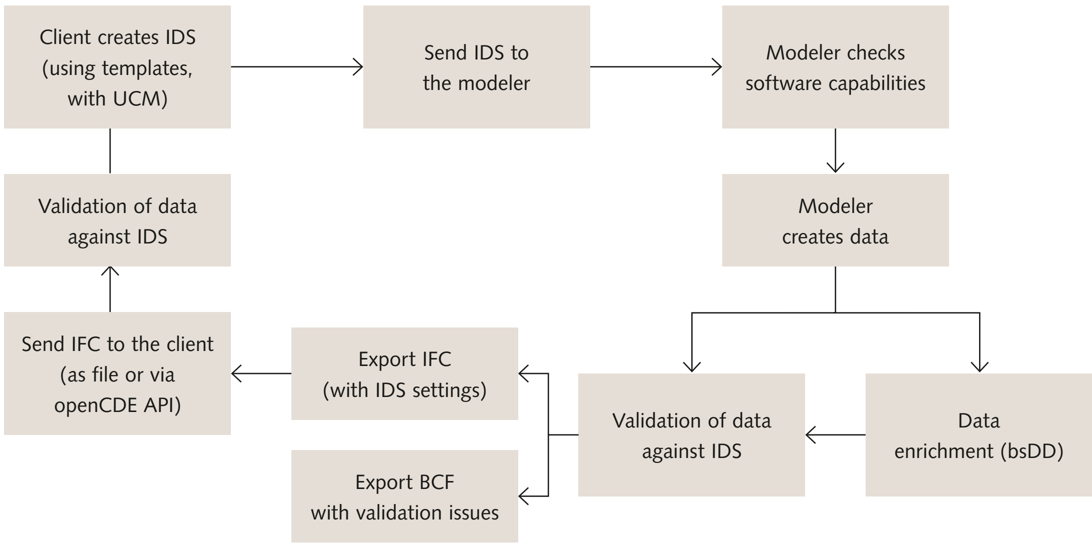


Figure 20
IDS workflow according to buildingSMART International

4.6 Data exchange and communication

The IFC (Industry Foundation Classes) according to SN EN ISO 16739:2024 [33] are a data schema for the standardized processing and exchange of building information in the construction industry. On the official website of buildingSMART international, under ‹IFC Certification Participants›, you can see which softwares are certified for which IFC versions and Model View Definitions (MVDs). The IFC version to be used must be determined at an early stage in the project management team. The IFC-schema mainly describes geometric and alphanumeric properties of buildings and their logical relationships. It includes collections of property names (PropertySets) and some generic texture information, which is represented in the form of property fields.

From coded properties to networked data dictionaries

Depending on the country, region, economic sector or company, the same properties are named, structured or detailed differently. In addition, the demand for property sets has increased to such an extent that they can no longer be transferred and maintained in the IFC-schema. The buildingSMART Data Dictionary (bSDD) was developed to meet the different requirements and to enable translation between the different stakeholder groups, but also between existing classification systems and IFC. [55] was created. In the bSDD, extensions such as classifications and properties from national standards or industry-specific guidelines can be stored and made accessible as independent dictionaries. These can be used as a basis for the development of specific use cases or for translation between different language regions, economic areas, classifications or sectors.

The following two bSDD entries relevant to timber construction were created in collaboration with Lignum and are already available to users:

- Harmonized construction product standards of the wood industry ‹Industry Dictionary for Products in Wood›
- Digital provision and processing of EPD Environmental Product Declarations ‹LCA Indicators and Modules›

Best Practice

IFC data exchange explained using the example of ‹Forms of trade› and ‹Properties› of construction products

The IFC data schema organizes building information (object classifications—entities—and their associated properties) in a defined structure: from the building (IFCBuilding), to components (e.g. IFCWall), to materials (IFCMaterial). This structure and the relationships defined within it form the basis for digital modeling of buildings in IFC—so-called building information models (BIM). Depending on the application and project phase, these have different levels of detail and different information content. Different model applications therefore require different filtering of the information (information extracts) from the IFC model.

> In analogy to the timber industry, IFC can be compared to a collection of all ‹trade forms› of components and building products as well as their ‹properties›. These forms of trade and properties must be specifically filtered and used depending on the application.

As the same requirements do not apply to load-bearing structures (e.g. IFCWall) and interior fittings (IFCCovering), the same information does not need to be exchanged for their planning and coordination. The IFC data model can therefore be filtered according to two dimensions: Entities (objects/functional units) and properties.

Filtering the exchange of information via Model View Definitions MVD

The Model View Definitions (MVD) determine which information is to be exported from the comprehensive IFC-schema and in what form this is done. MVDs are integrated into the export processes of various software solutions and enable a targeted selection of the relevant information for specific use cases.

> In analogy to the timber industry, an MVD corresponds to a defined ‹form of trade›: ‹Show me all timber components in the supporting structure, such as glulam and cross-laminated timber›.

Ordering information via Exchange Information Requirements (EIR)

The exchange information requirements EIR are used to determine which MVD is required and which specific properties the entities filtered in the MVD must have. They are usually structured according to project milestones and describe the required information deliveries per milestone (datadrops). They therefore describe the detailed requirements for the properties of the digital objects (model entities) that are relevant for the respective task.

> In analogy to the timber industry, the EIRs correspond to the required properties from the commercial form: ‹Show me only the properties 'density' and 'strength class'; I don't need other information such as the LCA data yet›.

Conclusion

A correct IFC export therefore includes both:

1. MVD: The ‹trading form› defined in the project execution plan, which specifies which digital objects are to be included in the information exchange (datadrop) and how.
2. EIR: Definition of which specific ‹properties› must be delivered for these objects at which point in time.

> In analogy to the timber industry: If only ‹one IFC› is issued and sent, this would be comparable to the delivery of all building materials required for construction (wood, metal, bricks, etc.) including all product data sheets in a single container to a carpentry company.

Information Delivery Specification (IDS)

An information delivery specification IDS is a predefinable and reusable machine-readable blueprint for the scope and structure of properties in accordance with exchange information requirements EIR. IDS can be read into authoring software as a basis for developing the required information. However, they can also be read into inspection software to ensure that the required properties are present

> In analogy to the timber industry: The IDS is the comparison between the requirements and the information actually supplied: ‹Have you specified all elements of the structure in the model?› and ‹Are the required properties 'density' and 'strength class' included everywhere?›

Standards and further developments in the timber industry

The IFC data fields and structures have long enabled the machine-readable exchange of building information. IFC distinguishes between generic object classes such as columns (IFCColumn), walls

(IFCWall) and slabs (IFCSlab) as well as building materials such as timber or concrete (IFCMaterial), which are provided with generic property sets (IFCPropertySet) and properties (IFCProperty). However, for a long time it was not possible to clearly map industry-specific generic properties or specific product information with properties according to standardization. The buildingSMART Data Dictionary (bSDD) now makes it possible for user groups such as industry associations or trade associations to define and make accessible their own specific information structures as generic entries in a central dictionary as machine-readable data fields and structures. More on this in chapter 6.

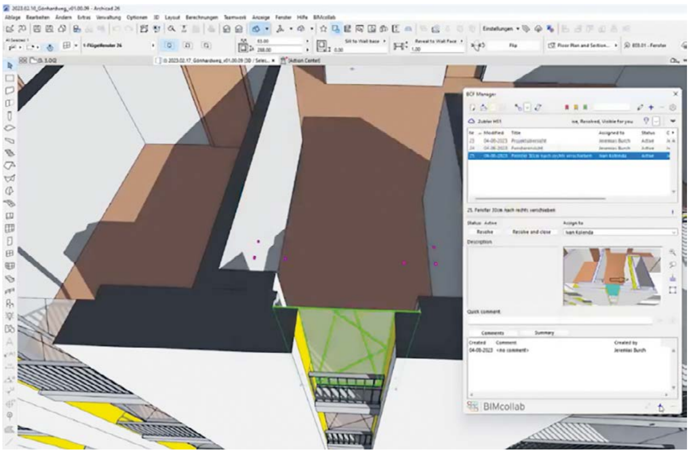


Figure 21
Communication via BCF

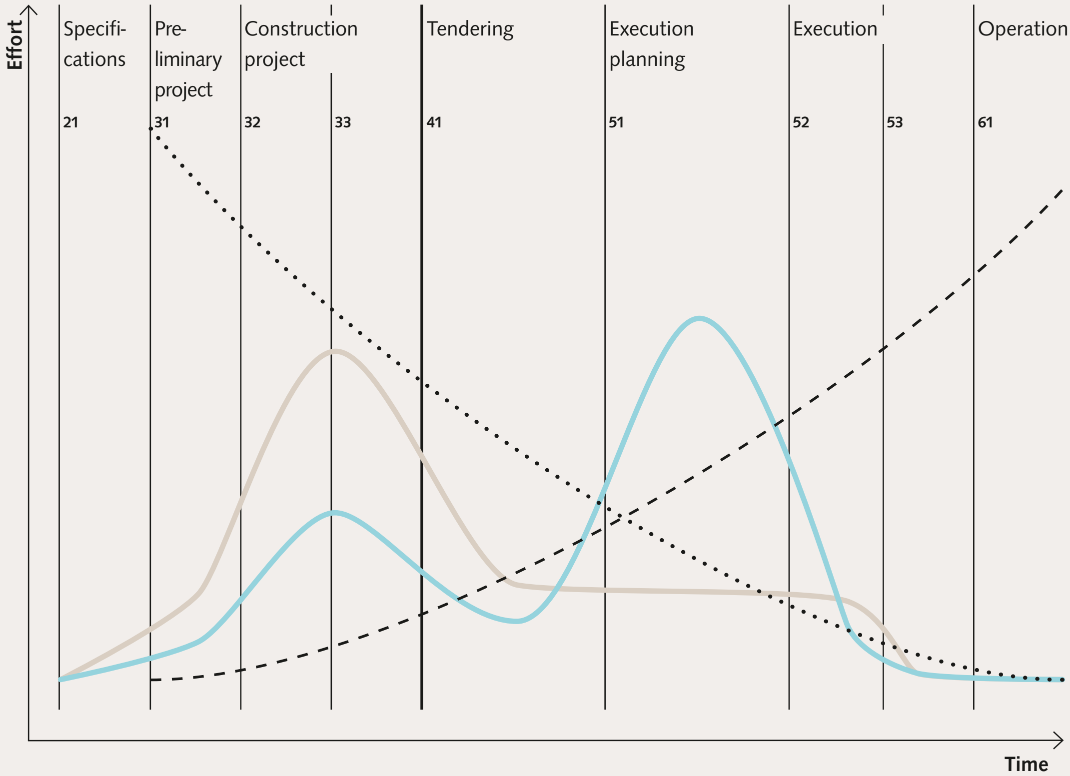
A major advantage of working with digital building models based on the IFC data schema is that communication is possible via the BCF BIM-Collaboration-Format.
Questions, corrections, and relevant information can be recorded and exchanged directly within the context, i.e. directly on the relevant 3D elements. Alongside the manually entered text, the IFC coordinates and the selected elements are automatically captured to ensure precise referencing. Depending on the software implementation, the BCF format (BIM Collaboration Format) can be created, exported, and imported directly within authoring tools such as CAD software. Alternatively, models can be exported using the IFC schema, with BCF comments subsequently added in model-checking software (ModelChecker) or through a BIM-capable project platform (CDE, Common Data Environment). This workflow enables the coordination information to be accurately localized, facilitating clearer communication and streamlining collaboration between project stakeholders.

Best Practice

Figure 22
Effort curve based on MacLeamy and STE [31]

SIA 103
Timber construction
Possibility to influence costs and functions
Cost of design changes

Project Phases



Effort progression and increase in accuracy in project phases according to SIA 112 [34]

Capturing notes in a fully model-based approach may require more effort initially compared to traditional 2D documentation or model-independent communication. However, this approach resolves relevant issues earlier and more comprehensively, reducing the workload in later phases while enhancing accuracy and quality. This represents a classic example of effort redistribution, often associated with BIM processes. To minimize the effort involved in addressing coordination points, a fundamental principle applies to both model-based and conventional project management: requirements must be clearly defined, and concepts must be developed and consolidated before proceeding to design detail coordination and adjustments.

Properly addressing coordination early ensures that potential collisions are prevented, not merely managed (compare Figure 9), thereby supporting efficient and high-quality project execution.

5 Project management with BIM in timber construction

There are now numerous publications that provide guidelines, principles and recommendations for the contractual regulation of project processing with BIM and the content of BIM project execution plans.

Some examples of this are
- Leaflet ‹BIM Project Execution Plan—Practice›, buildingSMART Switzerland, 2019
- Leaflet ‹BIM contract, roles, services›, buildingSMART Switzerland, 2018
- Website: ‹Digitization and BIM›, KBOB
- Publications by various trade associations

In the following, topics are presented that require specific clarification from a timber construction perspective or where challenges and errors can frequently occur.

5.1 Project management and organization

Best Practice

Organization of the cooperation
Effective collaboration requires clearly defined structures and communication channels. Each project team is unique due to the diverse backgrounds and skill sets of its members, and not all organizational forms or collaboration methods are suitable for every project task. To function effectively, project teams need time to understand each other's strengths and weaknesses, both formally and informally, and to develop a shared understanding of their roles within the team.

Ensure onboarding of team members
At the start of a project and whenever new members join the team—for example, during contract awards—attention must be given to the evolving dynamics of the project team. Sufficient time and appropriate methods should be allocated to integrate new members effectively. This ensures they understand the project's progress, objectives, and established definitions, enabling them to contribute purposefully and efficiently from the outset.

Develop a shared understanding of the project
A fundamental requirement for successful collaboration is ensuring that all team members have a clear understanding of the defined project objectives. Bridging knowledge gaps among new stakeholders can prevent their contributions from inadvertently conflicting with the project goals, which might otherwise cause unnecessary disruptions.

The ideal approach is to involve all relevant stakeholders from the start of the project. However, in practice, this is rarely feasible, as not all stakeholders are immediately relevant. Therefore, team-building and integration efforts should be planned and scheduled throughout the project lifecycle to ensure alignment and cohesion among team members.

Define the purpose of meetings
For effective collaboration, it is crucial to avoid categorizing every project-related meeting as a generic ‹workshop›. Each meeting should have a clearly defined purpose, specific preparatory tasks, and a structured implementation framework. Communicating these elements in advance enhances the productivity and focus of the team.

Potential purposes: Team building, Information exchange, Coordination, Joint solution development, Decision-making
Implementation frameworks: Physical (in-person), Digital (virtual), Hybrid (combination of in-person and virtual)

When a single meeting addresses multiple purposes, dedicated time slots should be allocated for each purpose, and the meeting should be moderated accordingly to ensure clear focus and efficiency.

Clear guidelines and well-defined structures are essential for the effective planning and execution of projects (see chapter 4.2). All project information must be fully available, including the client's specifications for content, deadlines, and milestones for information delivery. This encompasses normative requirements, standards, and guidelines (see Chapter 4.4), as well as the forms of information delivery and file formats (see chapter 4.4), as well as the forms of information delivery and file formats (see chapter 4.5 and 0) including version control.Additionally, it is essential to define the organizational levels and the expected scope of services for contractors. By systematically structuring foundational project information and organizational principles, responsibilities are clarified, and collaboration is optimized—laying a solid foundation for successful project implementation. However, achieving project success goes beyond management structures; it depends on fostering a collaborative culture and leveraging the appropriate tools for information and production management. Digital tools and methods, such as Building Information Modeling (BIM), offer new opportunities to enhance collaboration, streamline processes, and enable more efficient and effective project execution.

Collaboration strategy in project delivery
A clear collaboration strategy must be defined for collaboration throughout the entire project delivery phase, i.e. planning and implementation (see chapter 4.1). The two variants ClosedBIM and OpenBIM are available for discussion.

ClosedBIM methodology
The ClosedBIM approach requires all project participants to use the same software, relying on a defined, proprietary, machine-readable semantics. While this can streamline workflows within certain teams, it is not universally suitable, especially in timber construction. For example, generating machine data for computer-aided manufacturing (CAM) often requires specific planning software (CAD), necessitating additional data translation. ClosedBIM offers the advantage of a uniform software environment, simplifying workflows and data handling. However, it restricts flexibility, creates dependencies on proprietary systems, and can complicate tasks like CAM integration.

OpenBIM methodology
The OpenBIM approach allows the use of various software solutions as long as they adhere to open, machine-readable standards such as the IFC schema or bSDD. This promotes interoperability and flexibility, making it more suitable for multidisciplinary projects. OpenBIM facilitates collaboration across disciplines and ensures long-term data accessibility, but variations in IFC schema implementation across software can create inconsistencies, requiring additional coordination to ensure data integrity.
In timber construction, OpenBIM using IFC has proven effective for overall coordination, while in-depth collaboration in specific areas may benefit from native or bidirectional ClosedBIM applications.

Optimizing data exchange and software coordinatio
To address differences in IFC schema implementation and optimize collaboration, an overview of the software landscape should be established at the beginning of the project, documenting the software, versions, and tasks assigned to each participant. This ensures that data exchanges are tailored for compatibility. Coordination is also critical for software updates. Changes to versions or updates should only occur after consultation with the project team to prevent disruptions. This disciplined approach to managing tools and processes ensures smooth collaboration and aligns ClosedBIM and OpenBIM methods with project-specific requirements.

Data structure with property designations

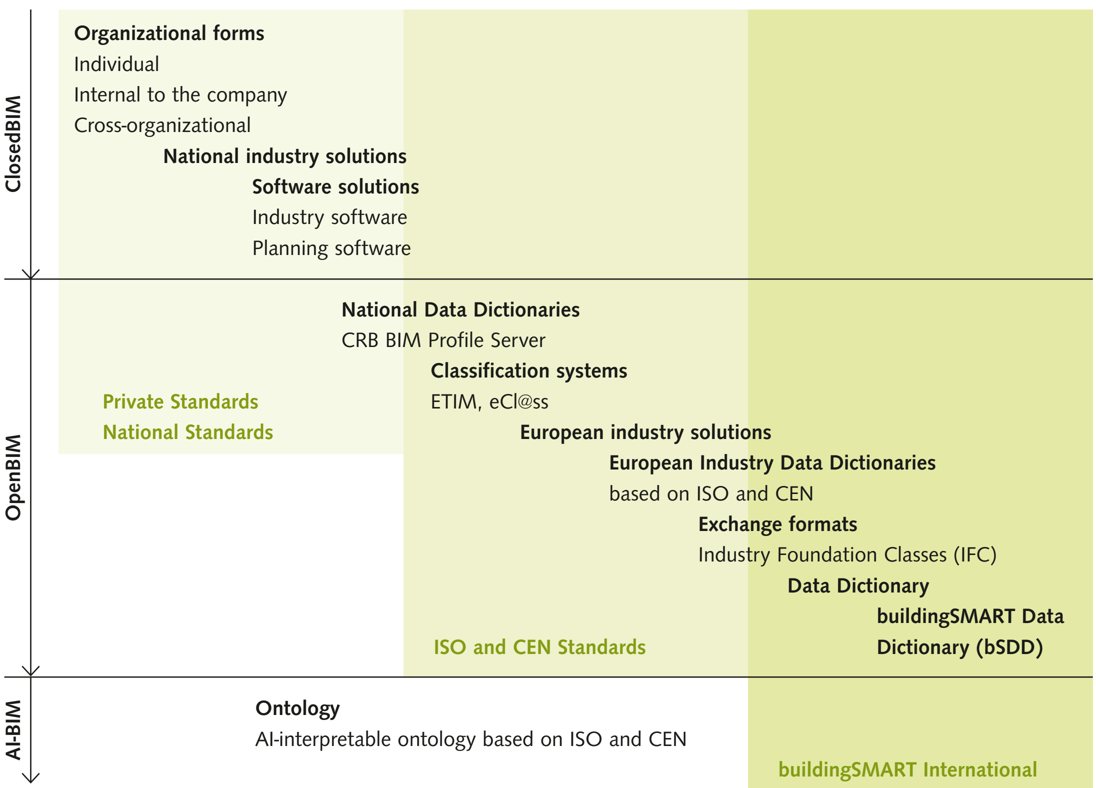


Figure 23
Levels of interoperability and machine readability

Best Practice

Optimized project management for timber construction projects

The introductory chapters of this document underscore the importance of integrated, interdisciplinary collaboration in developing sustainable, future-ready buildings. This approach moves beyond merely combining individual services, instead focusing on holistic coordination across all disciplines to achieve optimal outcomes. Moreover, the distinctive characteristics and specific framework conditions of timber construction are explored in depth. In modern timber construction, projects are predominantly realized through prefabrication and often adhere to a system-based construction methodology. This requires designing elements and modules as integral components of a cohesive system, necessitating the consideration and coordination of a wide range of factors that extend far beyond conventional structural planning.

The planning interfaces (who does what) and planning processes (what happens when) in timber construction differ fundamentally from the conventional project management methodologies and service divisions associated with traditional on-site construction:

- The focus, interfaces, and scope of services for timber construction engineers differ significantly from those of civil engineers [31]
- The phase content and time requirements in timber construction diverge considerably from the standard SIA performance models [31]

This means that adapted processes and phase content must be used for the successful implementation of timber construction projects compared to the current standard. The STE's Compact 01 ‹Services of timber construction engineers› (2020) provides the basis for this. [31]

At the same time, digital networking has given rise to numerous models for project management and methods of cooperation:

- Lean Construction
- Scrum
- Design Thinking
- Prototyping
- VDC (Virtual Design and Construction) [26]
- IPD (Integrated Project Delivery) [14]
- IPA (integrated project management)
- Project alliances [28]
- Design-Build

This diversification of project management approaches offers the potential to significantly enhance building quality. However, it also underscores the critical importance of clear agreements on collaboration within project teams. As new methods are introduced, participants must be properly supported and trained to ensure their effective implementation.

To achieve project goals and deliver optimal results, it is essential to maintain a consistent focus on the objectives, avoiding unnecessary distractions from organizational processes, administrative tasks, or overly complex tools. Successful project management lies in balancing innovation with practicality, ensuring that all efforts drive the project toward its intended outcomes.

5.2 Use cases

As explained in Chapter 3.2, specific use cases for the following areas must be defined for project management in timber construction:

- System construction and prefabrication
- Machine-supported production
- Material supply chains and logistics

Project-specific use cases also arise depending on the project objectives. At its core, the BIM methodology aims to use digital data processing with consistently structured data models. These are intended, for example, to improve the consistency of information, increase efficiency, enhance transparency and simplify communication, thereby promoting the effectiveness of the entire project.

New digital tools are constantly being developed to support the construction process through more precise planning, more efficient processes and better coordination between all parties involved.

They can basically be divided into the following application groups:

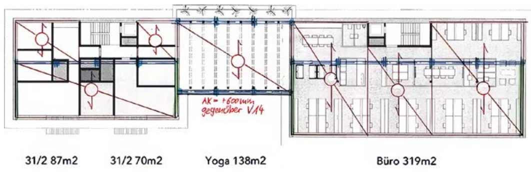
- Visualization, including dashboards
- Information evaluation and quantity determination, including cockpits and quality checks
- Information coordination and checking, including collision checks
- Simulations
- Machine controls
- Robotics
- Artificial intelligence

Figure 24
Examples of
data visualization

1 Requirements
2 Technical concepts
3 Requirements modell
4 Domain model

1

2



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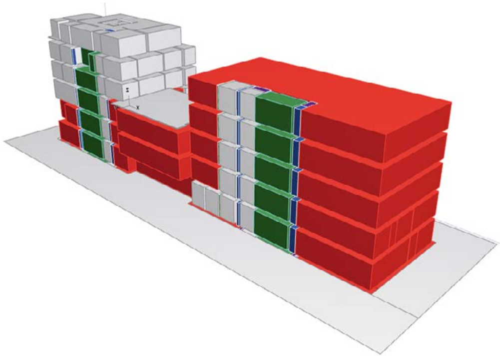

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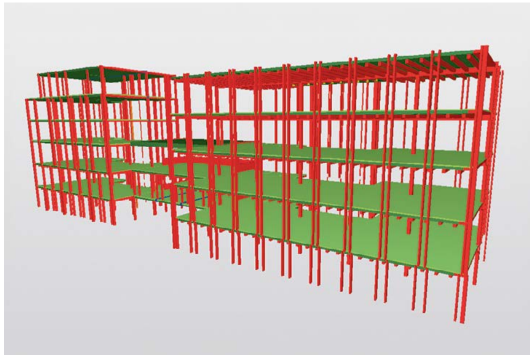


5.3 Information requests and information containers

Compliance with naming conventions for files, proper storage in designated locations, and adherence to defined communication channels are fundamental to efficient collaboration. The overarching objective of BIM-based project management is to minimize errors and misunderstandings while establishing a single ‹source of truth› for each project or asset.
The delivery phase of a project, executed using the BIM method, relies on a comprehensive digital project information model. This model integrates the architectural model with the specialized models from various disciplines developed during the planning phase, as well as the production or workshop planning models created by contractors.
It is crucial to emphasize that an information model is not merely a 3D model. It represents a collection of structured, complete, and accurate information that aligns with the requirements of the project assignment. The specifics of which information must be delivered, and in what format, must be clearly outlined both in the preBEP (pre-appointment BIM Execution Plan) and the BEP (BIM Execution Plan), ensuring seamless cooperation among project team members. This clarity in expectations and deliverables is essential for achieving project success with the BIM methodology.

Exchange Information Requests (EIR)
To effectively understand and process the Exchange Information Requirements (EIR), it is essential to grasp the underlying objectives, and the use cases derived from them. The EIRs should be aligned with clearly defined Levels of Information Need (LOIN) and linked to specific project phases or milestones. They must also specify the required forms of information delivery, which may include BIM models, tables or data sets, and documents. Collectively, these delivery forms are referred to as ‹information containers›. [13] In timber construction projects, it is particularly critical to integrate timber-specific information requirements into the project management process at an early stage. Special attention must be given to the interface between planning and production or workshop planning, as this is a key area where precise coordination ensures that the project objectives are met and that the transition to manufacturing processes proceeds smoothly.

Best Practice

Timber construction-specific information attributes
The use case ‹Component requirements for multi-layer standardized structures in timber construction› documented on the Use Case Management Platform (UCM) of buildingSMART International [24] proposes standard attributes that can be used to describe component requirements in timber construction:

Attributes
- Status: New; Existing; Demolition; Temporary
- Load-bearing component: Yes; No
- Bracing component: Yes; No
- External component: Yes; No

Requirements
- Fire resistance class of the component: Values according to VKF
- Fire behavior group of the material: Values according to VKF
- Protection time of the supporting structure: Values according to VKF
- Airborne sound insulation D_i: [dB]
- Impact sound insulation $L_{'n,w}$: [dB]
- Heat transfer coefficient requirement: [W/(m² *K]

These attributes can be used to create specific requirement profiles for components in the early project phases. Based on these profiles, suitable construction variants can be searched for in component databases such as Lignumdata. These variants can then be compared with each other and evaluated in terms of their suitability for the project objectives.

Additional attributes
As the project progressed, it proved useful to also use the following requirement attributes for component structures:
- Airtightness requirement: Yes; No
- Surfaces (visible/non-visible)
- Surface quality

and for structural components:
- Component quality: e.g. GL24, C24
- Wood species
- Trading form
- Special features: e.g. superelevation, preload
- Item number according to position plan [31]
- Dimensions
- Fastening/mounting method

Differentiation of attributes for requirements and services
It is important that for this application, the comparison of requirement attributes with effective performance attributes of component superstructures, the two attribute types must be clearly differentiated. The ‹Fire protection planning for building permit› use case on the UCM platform proposes the following definitions:
- Requirements information: Description of the fire protection requirements for a construction project or its functional units (entities)
- Planning information: Description of the intended design solution to meet the requirements
- Performance information: Description of the declared performance values of the installed component based on its individual layers and their materials

To clearly identify requirement attributes in BIM models, it is recommended that these are always given the extension ‹Req› in order to identify them as such throughout the planning process (e.g. ‹FireRatingReq› for the requirement for the fire resistance class).

5.4 Process and coordination

An essential aspect of process planning (or planning of planning) is the definition of key milestones for the project and the collaborative development of a detailed planning process within the project team. This is typically done using a pull planning methodology, starting with the project completion milestone and working backwards to define intermediate steps and requirements. Process planning should also incorporate considerations for various award and cooperation models, coordinated usage agreements, and model-based approval processes. These elements help ensure alignment among stakeholders and streamline project workflows. Rather than introducing additional roles specific to BIM project management, the focus should be on clarifying responsibilities and interfaces. Clearly defined roles and interfaces are critical to fostering efficient collaboration, reducing redundancies, and ensuring that all team members understand their contributions to the project's success.

Best Practice

Process factors specific to timber construction
These factors ensure the structured and coordinated handling of timber construction projects by taking into account the specific requirements of timber construction and optimizing the entire process from planning to assembly.

- Project participants and sponsors
  - Coordination of concepts and solutions
  - Coordination of production/workshop planning
  - Coordination of logistics and assembly
- Timber construction-specific goals and use cases
  - According to chapter 3 and 4.2
  - As described in chapter 5.2
- Definition of planning depths in relation to the project phase in connection with variant studies
- Generic coordination process with the aim of prefabrication (coordination program)
- Testing and approval processes
  - Planning control process ‹Good for production›
  - Work preparation and production process
  - Production planning (sequence, timing)
  - Production inspection process ‹Good for assembly›
  - Order processes (cost breakdown, tracking, documentation)
- Data management and communication including entrepreneurs (e-mail, planning platform, task management tool)
- Tolerance definition and management
- Procurement of materials, especially for large-scale projects, special buildings and with regard to regionality
- Logistics planning
- Assembly planning (sequence, timing)
- Construction time sealing

Interface and model coordination in timber construction
Modern timber buildings often integrate various construction methods, adding complexity to project management. It is essential for the planning team to understand the system logic of the different components early in the process. Given the prefabrication involved, special attention must be given to interfaces with other construction methods, such as in-situ concrete, and to coordination with other trades, particularly building services engineering. Structural systems in timber construction primarily rely on linear components, such as columns and beams, which offer limited or no capacity for breakthroughs. Consequently, early coordination of these linear components with other planning disciplines and trades is critical to ensure seamless integration and avoid conflicts during construction.

The following types of model have proven their worth:
- Structural system model
- Timber construction sub-model
- Restricted zone model

Who is responsible for which part of these models must be clarified for each project team and project task. As architecture is usually responsible for overall coordination, it makes sense for architecture to create the partial model for the timber structure, depending on the scope and type of timber structure. The structural engineers can then check it and supplement it with exclusion zone information. A restricted zone is an area in the structural design that must be kept free of interventions such as drill holes, penetrations or loads for structural, design or functional reasons in order to ensure the safety and stability of the structure.

Best Practice

Model coordination of timber construction systems

This table describes the requirements for the coordination of timber construction systems in practice. Each type of structure has specific requirements for spatial coordination (LOG and LOI) as well as the definition of exclusion zones and other parameters for load transfer and bracing.

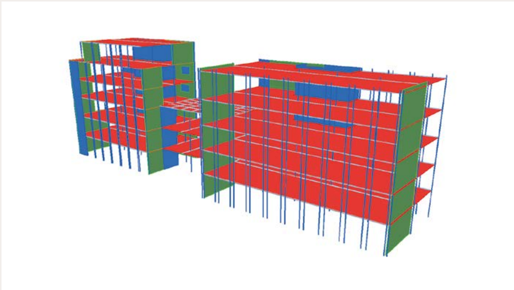


Figure 25
Structural system model
- Toad-bearing elements vertical
- Load-bearing elements vertical
- Load-bearing and bracing elements horizontal

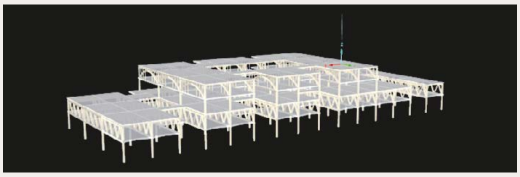


Figure 26
Timber construction sub-model

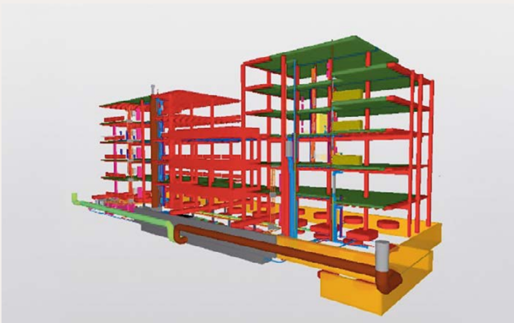


Figure 27
Building model with different types of restricted zones in timber construction
- No openings, no conduit routing
- Openings upon agreement, no conduit routing
- Openings upon agreement, conduit routing in tension direction
- Installation zone

Timber construction system	Type of structure	LOI spatial coordination	LOG spatial coordination
Skeleton construction	Bar supporting structure	– Specification of the clamping direction for ceilings – Differentiation between different types of exclusion zones – Definition of maximum opening sizes in ceiling panels	The following areas are defined as restricted zones: – Connection areas for nodes and supports as restricted zones – Bracing in the form of panels or bars – Substitutions for openings
Timber frame construction & Solid wood construction	Surface support structure		
Hybrid construction	Supporting structure with combined materials (all load transfer situations possible)	– Separation of specific exclusion zone areas within a component	– Connections and connection areas for nodes and supports

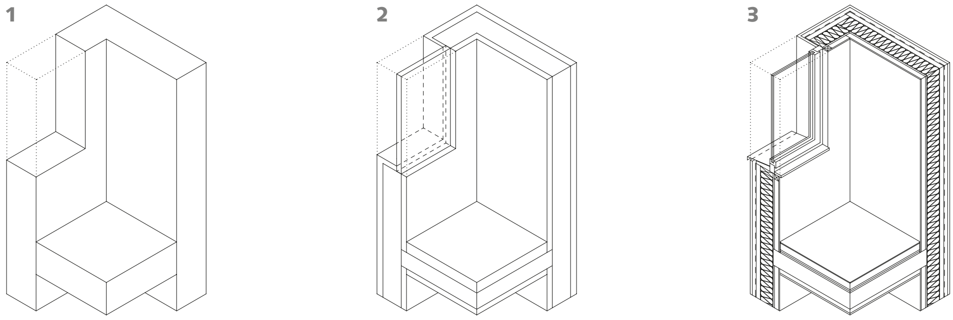


Figure 28
Levels of detail of envelope models according to BIMwood [15]

1 Single-layer (entity with requirements)
2 Three-layer (supporting structure with cladding according to eBKP-H element groups)
3 Component-specific (all building materials specified with construction details)

Coordination of construction details and component structures
An essential aspect of coordinating timber structures lies in the construction details, particularly the joints and connections, which are critical for efficient prefabrication and high execution quality. A streamlined set of construction details reduces both the execution effort and the risk of errors while enhancing the reusability of the structure at the end of its lifecycle. For an optimal coordination process, the zone and space requirements are defined during the preliminary project phase. These requirements serve as the foundation for deriving and coordinating the component specifications (Figure 12). Based on these specifications, the component structures can be developed and aligned, providing the groundwork for defining the supporting structure and reserving materials as needed. The process concludes with the determination of the final cladding layers and material selections, ensuring a coherent and well-integrated design.

Standardized naming and coordination of component structures
In system construction, particular attention must be given to the coordination of building elements and components during the planning phase, as these are typically prefabricated. The designations for components (entire elements) and their layers (system classification according to eBKP-H), which may also be assigned to different lifetimes for Life Cycle Assessment (LCA), must be consistently defined across the project team. This includes the functional layers associated with individual building materials, ensuring uniformity across all forms of information delivery, such as component catalogs, component lists, and models. [13]
Clear and unambiguous designations simplify coordination within the planning team, eliminating the need for time-consuming alignment of terminology. Moreover, standardized naming conventions allow for the seamless linking of plans for component assemblies through project platforms (Common Data Environments, CDE) with the corresponding components or building elements in the models. This consistency enhances communication and understanding, significantly improving the efficiency and quality of the planning process.

Improving efficiency through early coordination and clear interfaces
Insufficient coordination during the planning phase often results in planning models that cannot be directly utilized for production and workshop planning. In most cases, a new digital model must be created to generate production data. While it may not be feasible in the near future to derive production data directly or automatically from planning models, early clarification of requirements and clearly defined interfaces can significantly reduce the coordination and communication effort. This enhances both the efficiency and effectiveness of all project participants. Key to this process is defining and maintaining the required accuracy and achieving a sufficient level of planning completion (e.g., freeze shell construction).

Integration of the trades to avoid collisions
When preparing production documents, it is crucial to ensure that there are no collisions between timber construction elements and other building components, such as solid construction, building services, and interior extensions. Additionally, connection details must function correctly, and required substructures must be properly planned.
To achieve this, the companies responsible for the respective trades must be identified and integrated into the project team before production document preparation. This ensures that all interfaces are feasible and that the necessary accessibility and space conditions are provided for standard-compliant execution and assembly.

Best Practice

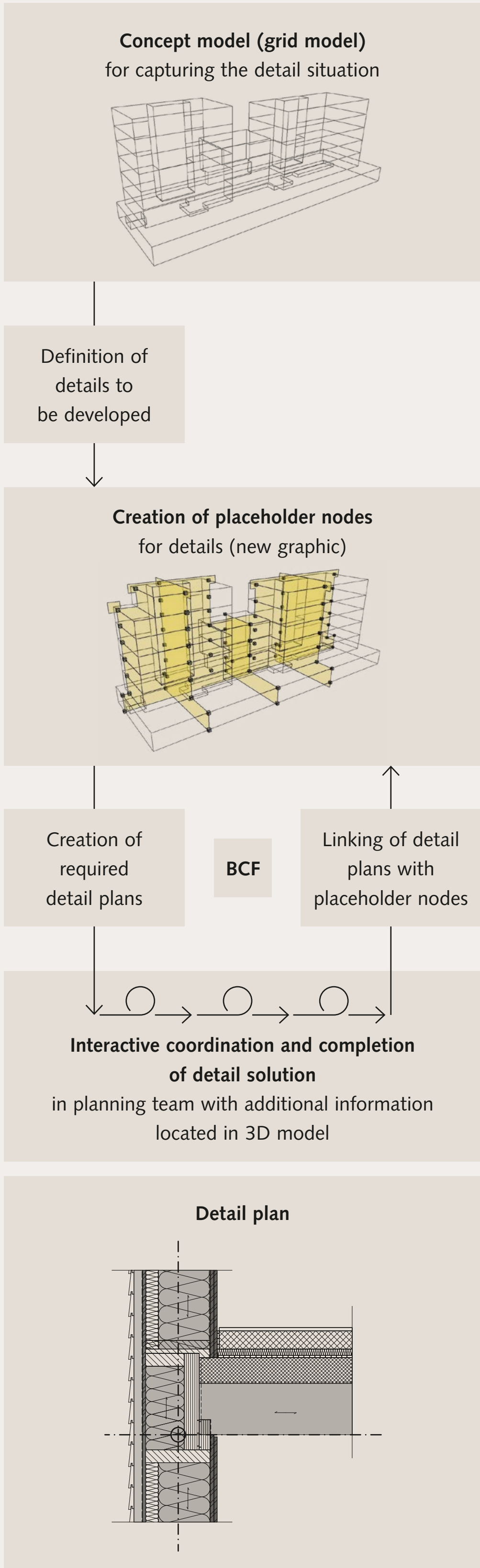


Figure 29
Typing of constructive nodes as a basis for interdisciplinary construction detail development

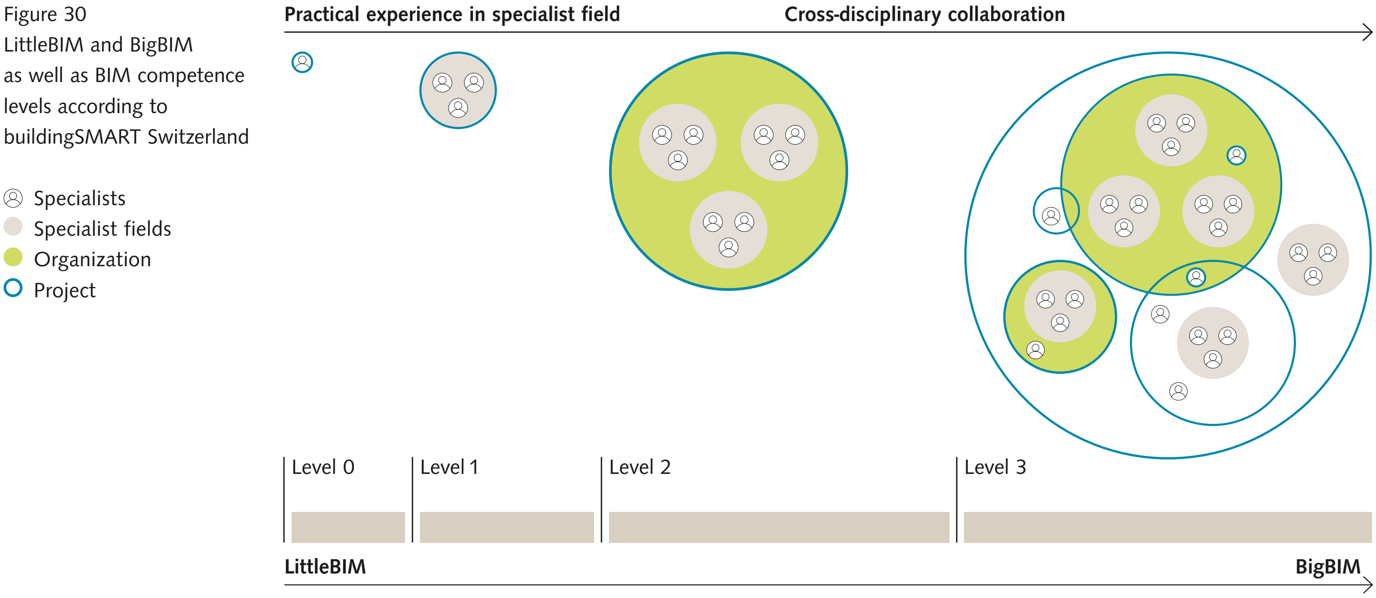
Coordination of joints and construction details

The requirements for joints and connections, i.e., construction details, must be comprehensively recorded and coordinated starting from the design stage of a building. It is essential to clearly define which axes are critical for the joints and to assess whether the number of different joint details can be minimized. Reducing the variety of joint types simplifies execution, reduces error potential, and enhances efficiency.

To ensure clear communication and consistency, all construction details must be assigned unambiguous designations that are coordinated and uniformly applied across all planning parties, including architecture, timber construction planning, and timber construction execution. These designations should be clearly represented in 2D plans and 3D models and supported by detailed documentation in construction drawings.

Once coordinated, these construction details can be effectively utilized throughout the entire life cycle of the building—from the initial provision and operation phases to eventual dismantling—ensuring long-term usability and facilitating reuse or recycling.

Figure 30
LittleBIM and BigBIM as well as BIM competence levels according to buildingSMART Switzerland



Model coordination from planning to production
The model types used in planning must also be coordinated in terms of their respective degrees of completion before production begins, with a clear focus on producibility and buildability. This coordination is critical for the iterative process between planning and realization. A model plan should define which models are to be developed, coordinated, and assembled by whom throughout the entire project delivery phase, encompassing both planning and realization. [13] This includes the essential interface to production and workshop planning. Rather than relying solely on completed specialist models, it has proven effective

Best Practice

What is included in the production and workshop planning model?

Production Information
- Material Specifications: Detailed requirements for ordering materials.
- Degree of Prefabrication: The extent to which components are prefabricated.
- Processing Location: Identification of whether components are processed externally or in-house.
- Machine Data: Data required for automated production processes.
- Joinery Plant: Specifications for bar processing in timber joinery.
- Component Optimization: Adjustments to ensure compatibility with purchased/stock products.
- Joinery Optimization: Planning joinery stages for batch sizes, floors, wall types, and other parameters.
- Sorting for Processing: Allocation of components for further processing (e.g., construction site vs. production).
- Pre-Assembly: Integration of fasteners, hardware, and other pre-assembled parts.
- Panel Cutting: Precise specifications for cutting panels.
- Production Grouping: Grouping components into production batches as required.
- Element Production:
- Nail bridge/element production stages.
- Optimization of panel construction materials for efficient procurement and usage.
- Element Manufacturing: Detailed specifications for the production of elements.
- Logistics Preparation: Specifications for loading onto flatbeds.

Assembly and Logistics Information
- Element Weights: Weight details for individual elements.
- Element Dimensions: Accurate dimensions for elements.
- Loading Planning: Strategy for loading elements for transport.
- Assembly Dates: Scheduling for on-site assembly.
- Suspension Details: Information on suspensions required for loading and assembly.
- Construction Site Details such as: access road specifications and crane locations and setup requirements.

to create separate sub-models for individual disciplines. These sub-models are coordinated and reviewed to ensure their content aligns with project objectives. Ultimately, the sub-models are integrated into a comprehensive model, either as part of the Project Information Model (PIM) or, finally, as part of the Asset Information Model (AIM).

5.5 Technical guidelines

The modeling guidelines defined in the BIM Execution Plan (BEP) expand upon the model plan by providing detailed technical specifications that apply to all models. These guidelines regulate the geometric structuring of models, addressing aspects such as topology, spatial coordinates, and export requirements to ensure consistency and compatibility across disciplines. It is the responsibility of the designated personnel in each discipline to ensure that their specialist models comply with these technical guidelines. Before uploading or sending their models, they must verify adherence to the specifications outlined in the BEP. To maintain clarity and accountability, models must contain only elements relevant to the respective discipline for which the responsible party has technical oversight. Cross-disciplinary elements should be excluded to avoid confusion or redundancy.

The following data exchange agreements require special attention [10]:

- Specifications for the model export regarding IFC version and Model View Definition MVD
- Floor structure, content and allocation
- Project zero point
- Insertion points
- Georeferencing and north alignment
- Plan export specifications regarding georeferencing and north orientation

Georeferencing
Georeferencing is a recurring source of errors and confusion. With most common authoring software, it is now possible to easily switch between georeferenced and non-georeferenced output by making the correct settings.

Determination of the storey contents
Accurately defining the storey contents according to the agreed specifications is essential for seamless coordination. All models within a project must be implemented uniformly to ensure smooth functionality during storey-by-storey checks in inspection software. Inconsistent implementations can lead to unnecessary errors and misunderstandings. Since there is no universally valid definition of storey content, it is vital to establish a clear and consistent definition for the entire project team. Prior to the first data exchange, these definitions and settings should be clarified with the support of the relevant software to ensure their accuracy. A test exchange or proof of concept (PoC) should then be conducted to mutually verify and confirm the settings, ensuring that all parties are aligned and that the process runs efficiently.

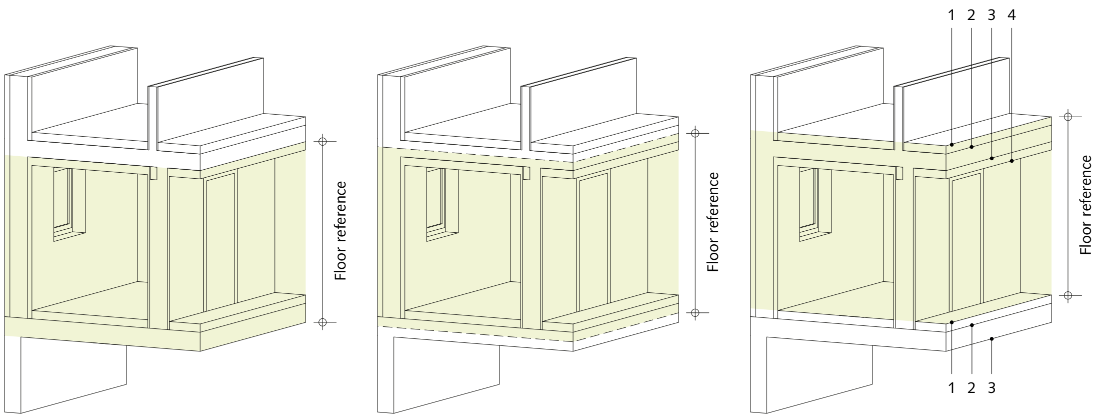


Figure 31
Examples of different floor definitions

1 Top edge of finished floor
2 Top edge of rough floor
3 Bottom edge of rough slab
4 Bottom edge of finished slab

6 BIM in life cycle analysis and reuse

Net zero emissions in the building sector
Switzerland is aiming to become climate-neutral by 2050. The construction industry also plays a key role in this: the production and disposal of building materials have a major impact on the environment. The production of cement and steel, for example, is each responsible for around 8% of global CO_2 emissions. In order to achieve this goal, both the number of renovations and the impact of the individual measures must increase significantly. This requires effective methods for assessing the environmental impact of building materials.

Cooperation with the EU and adaptation of the construction industry
Switzerland is working closely with the EU to achieve these climate targets and supports the initiatives of the European Green Deal. The Swiss construction industry needs to adapt to this long-term strategy, as instruments such as the Digital Product Passport (DPP) or the EU taxonomy, which evaluates economic activities to promote sustainable investments, will also influence the Swiss construction and real estate industry.

The SIA action plan
The SIA has developed an action plan for ‹Climate, Energy and Resources› to prepare the industry for the challenges of climate change. The plan focuses on awareness-raising, CO_2 reduction methods, project coordination and the creation of a sustainable living environment.

Life cycle assessment data
This is where the life cycle assessment data of construction products comes into play: it allows architects, engineers and all other construction decision-makers to consider the environmental impact of construction products and materials right from the start. Integrating life cycle assessment into the BIM working method can make these processes much easier. [22] The revised Construction Products Regulation of the EU (new-CPR), provides a consistent framework for the provision of LCA data in the mandatory part of product declarations (DoP).

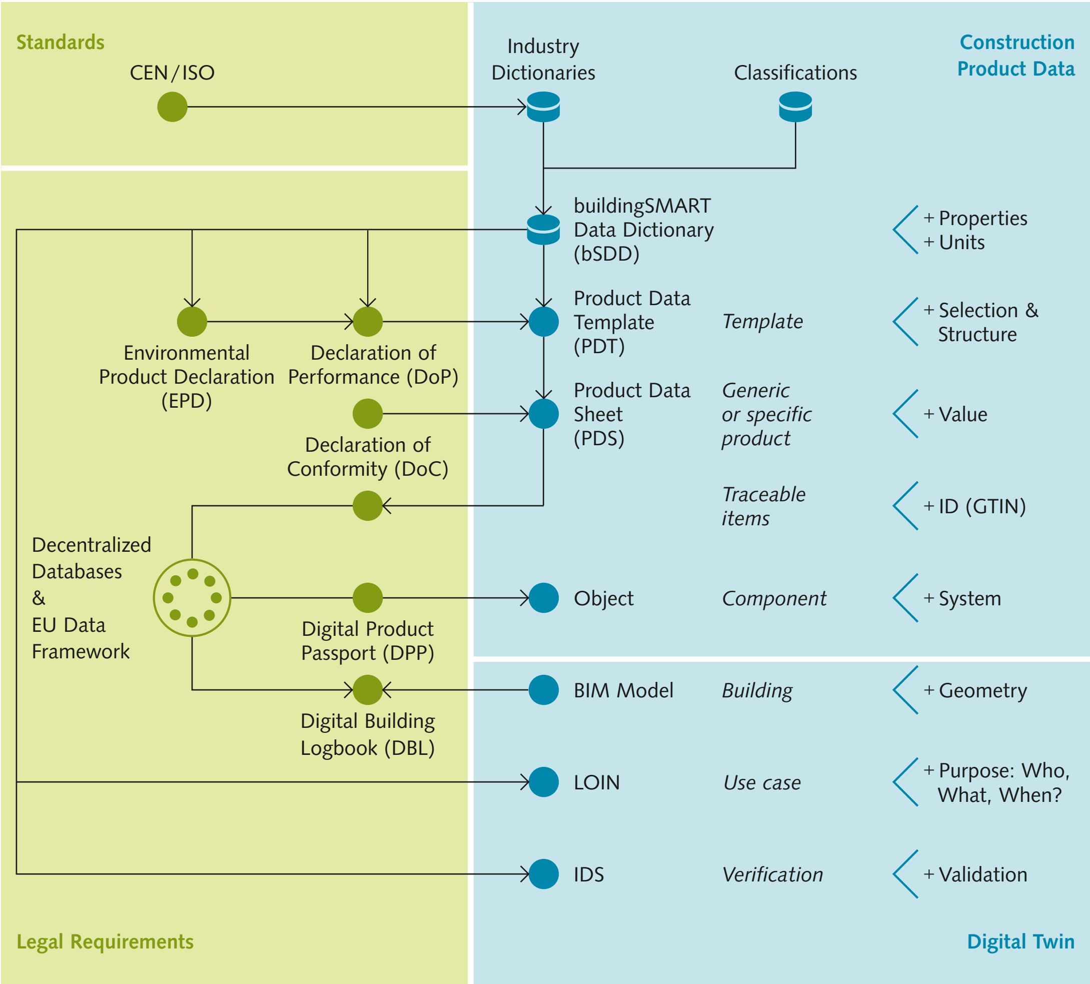
Building Information Modeling (BIM) and sustainable construction processes
Machine-readable data is a cornerstone for achieving climate targets, as it enables data-driven decision-making and fosters quality competition and innovation in the construction industry. Integrating environmental requirements into all construction processes is critical to establishing a sustainable construction and real estate sector. Building Information Modeling (BIM) plays a pivotal role in this transformation by facilitating comprehensive life cycle assessments and advancing the circular economy through detailed planning and management of material information. The digital documentation of a building using BIM allows for enhanced resource and energy efficiency, as all relevant information about the building and its materials is digitally interconnected and readily accessible. To meet medium- and long-term climate targets, the consistent implementation of these requirements is essential. Achieving this, calls for close collaboration among governments, companies, and other stakeholders in the construction industry, ensuring that sustainability becomes a standard part of construction processes.

Data dictionaries
The international standard SN EN ISO 23386:2020 describes the ‹Methodology for describing, creating and maintaining properties in networked data dictionaries›. It is the basis for translating human-readable standards into a structure that can be read by the programming language and then published in digital dictionaries such as the buildingSMART Data Dictionary (bSDD).

Best Practice

The Swiss timber industry as a digital pioneer
Inspired by Lignum's preliminary work in the Product Domain Steering Committee of buildingSMART International, ISO 23386 was applied for the first time to the properties of environmental product declarations (EPD) in accordance with ISO 21930:2017, and the data was published under ISO 22057 with an accompanying Excel file. Lignum prepared the data in parallel in a user-friendly way and transferred it to the buildingSMART Data Dictionary (bSDD).
This step from human-readable texts in standards to machine-readable data has already been successfully implemented by the TIMBIM initiative of the European association CEI-Bois for harmonized construction products in wood: In the bSDD's ‹Industry-dictionary for products in wood›, the properties of 13 harmonized construction product standards (hEN) as well as all possible properties for wood species have been published. [51] As a member of the European association CEI-Bois, Lignum co-founded the TIMBIM initiative to create a European data dictionary for all construction product standards for wood harmonized in Europe. Each entry in the bSDD is given a unique identification number (UID), which enables consistent and precise data management across borders. This means that, in the future, both requirements and manufacturers' product performance can be described using a common, machine-readable dictionary. This serves as the foundation for the digitally networked use of construction product information in the form of a Digital Product Passport (DPP) within the BIM methodology.

Figure 32
Framework for networked building products as a basis for circularity



The digital product passport (DPP)
The Digital Product Passport (DPP) leverages the buildingSMART Data Dictionary (bSDD) to compile Product Data Templates (PDTs)—standardized forms completed by distributors. These templates serve as a basis for the digital documentation of construction products, which can then be linked to specific instances (elements) in construction projects. By standardizing and structuring product information, PDTs streamline communication across the supply chain and among construction stakeholders, transcending national and industry boundaries. To fully integrate building product data into the building planning process, manufacturers must provide their product performance data in a digital and structured format (DPP). This requires the industry to first identify specific product properties and establish uniform naming conventions. The adoption of Product Data Dictionaries (PDDs) facilitates the creation of high-quality, standardized data for construction materials and products, enabling seamless communication and collaboration across different countries and sectors. By standardizing data exchange and documentation, the DPP supports efficiency, transparency, and sustainability in construction processes, aligning with modern digital construction practices.

Digital product passports as the basis for the integration of building product data
Digital Product Passports (DPP) enable the declaration of product properties and their tracking along the entire value chain. Data from building models can be used to improve the assessment of environmental impact and recyclability, which also facilitates market surveillance. A feasibility study is currently investigating options for an EU-wide database to facilitate implementation.

6.1 Circular construction and reuse

The optimized use of wood in construction plays a crucial role in achieving climate targets. Prefabricated elements, modular construction methods, and assembly systems create ideal conditions for future disassembly and reuse. Reversible connections facilitate the dismantling process, enabling components, structural elements, and individual parts to be reused with minimal effort. This approach extends the lifespan of materials, conserves resources, and significantly reduces construction waste. Reuse strategies help maximize the carbon storage potential of wood and lower CO_2 emissions. Pilot projects in circular timber construction aim to gather practical insights and drive further development. Lignatec No. 36—‹Wiederverwertung von Bauholz für tragende Zwecke› provides detailed information on the circular economy potential of solid wood and glued laminated timber products in the construction sector.

Life cycle analysis and BIM: Efficient integration for sustainable construction
By utilizing the BIM methodology alongside specific calculation tools, buildings can be optimized early in the planning stages. The integration of life cycle assessments (LCA) into BIM workflows simplifies the calculation process, making it more accessible and fostering the widespread adoption of life cycle analysis within the construction industry. Emerging open standards from buildingSMART International will further enhance this process by enabling the creation and retrieval of building product data through a digital product passport (DPP). This advancement will significantly improve the quality and accessibility of data, promoting more accurate and efficient sustainability assessments. The online course www.bim-lca.ch showcases practical examples of how digital tools already support life cycle analysis, providing valuable insights into their application. These tools help advance sustainable construction practices, demonstrating how technology can drive more environmentally conscious decision-making in the built environment.

Current state of research on circular timber construction

The research report circularWOOD [11] stems from a collaboration between the Chair of Architecture and Timber Construction at the Technical University of Munich (TUM) and the Competence Center Typology & Planning in Architecture (CCTP) at the Lucerne University of Applied Sciences and Arts (HSLU). It offers a comprehensive overview of the current state and challenges in circular timber construction. Key areas of focus include the need for standardization, precise and context-specific documentation of joints (connections and construction details), and the critical importance of close collaboration between planners and contractors. The study Reuse in the Swiss Construction Industry, conducted by the Departments of Economics and Architecture, Wood and Construction at Bern University of Applied Sciences (BFH) [18], analyzes reuse practices in the Swiss construction industry, identifying key opportunities, challenges, and recommendations for action.

Challenges and opportunities in reuse for the construction industry

The reuse of building components in the construction industry offers significant potential for sustainability but is accompanied by notable challenges. Key obstacles include the reluctance to pay higher prices for reusable components and the often-substantial costs associated with their recovery. Additionally, there is a lack of comprehensive data regarding the availability, location, and quantities of reusable components, both for current and future projects. Reuse impacts the planning process, as it requires the integration of existing components into new designs or sourcing appropriate components for specific project requirements. This often necessitates additional effort and adjustments in design workflows. Moreover, new logistical challenges arise due to timing and spatial mismatches between material availability and project demands, creating needs for transportation and storage solutions that align with these constraints. Another significant barrier is the limited dismantling capability of many currently used components, which often leads to high costs during deconstruction and complicates material recovery. To overcome these challenges, the industry must adopt innovative planning approaches, such as design for disassembly, which facilitates easier recovery, reuse, and recycling of materials at the end of a building's lifecycle.

Normative and legal framework for reuse

The legal and normative frameworks governing the reuse of building components and materials remain underdeveloped. Key questions include: Can certain aspects of their usability be presumed for reuse? Or must the essential characteristics—outlined in a declaration of performance (DoP)—be re-tested, and if so, according to which standards? Establishing clear legal and normative guidelines is essential to facilitate the broader adoption of reuse practices in the construction industry.

Strategies and standards for circularity

buildingSMART Switzerland has published two whitepapers that address important strategies and standards for the construction and real estate sector. The white paper ‹Digitally networked building product data as the basis for circularity› [8] presents EU and Swiss initiatives and standards for the construction and real estate sector. The white paper ‹Digital Product Passport (DPP) for Construction Products› [9] describes the creation of product passports in accordance with the newCPR based on data dictionaries.

Best Practice

The current legal situation offers opportunities for reuse

Under Article 7 of the BauPG (Swiss Construction Products Act), the Federal Council has the authority to define performance classes for the essential characteristics of construction products and specify the conditions under which a construction product can be considered compliant with a particular performance level or class without the need for additional testing. If such classification systems are established, the relevant federal and cantonal authorities are only permitted to define the threshold values or performance classes for construction products applicable in Switzerland according to these systems.

Article 5 of the BauPG states that a declaration of performance is not required for construction products if they:

a) IAre manufactured individually or as custom-made products upon special order, and are installed in a specific structure, where the manufacturer is responsible for ensuring the safe installation;
b) IAre produced directly on the construction site in accordance with the relevant installation regulations;
c) IAre manufactured through non-industrial processes, traditionally or for the preservation of cultural heritage, in compliance with regulations, particularly for the renovation of buildings officially protected for their architectural or historical value, or as part of a protected site or landscape.

7 Glossar

In the national glossary on digital planning, construction and operation, it was agreed to use the English abbreviations in norms, standards and documents due to Switzerland's multilingualism.

7.1 Basic concepts

CAD
The term ‹Computer Aided Design› is usually used as a collective term for drawing software in (construction) planning.

CAM
The term ‹Computer Aided Manufacturing› is usually used as a collective term for drawing software for controlling production machines in the (construction) industry.

Delivery phase
Development, design and planning phase.

Operational phase
Operation and maintenance, facility management
Concerns modules B in the life cycle according to ISO 21930:2017 or SN EN 15804

Information on
Contextualized data: e.g. ‹30/50 mm slat dimension›.

Knowledge
Cross-linked information: e.g. ‹30/50 mm is a standard slat dimension›.

Specialist knowledge
Competence to develop and interpret technical data and information models. It is often also informal knowledge based on networked information.

Lean Construction
A management method in the construction industry, derived from the principles of the Toyota Production System. It aims to optimize processes, reduce waste (time, materials, resources), and maximize customer value. Lean Construction promotes collaboration among stakeholders and continuous improvement throughout the entire project lifecycle.

newCPR
The ‹new Construction Product Regulation› is based on EU Regulation No. 305/2011, regulates the free trade and safety of construction products within the European internal market and will also apply in Switzerland as a result of the amendments to the Swiss Construction Products Act (CPA) and the associated ordinance required by the MRA.
EU Regulation No. 305/2011

PoC
The ‹Proof of concept› can have various meanings in the context of construction project management with BIM:
- Comprehensive check of the status of project development in relation to the project objectives before phase completion
- Test exchange of BIM models to check whether the model-based collaboration works as described in the BEP

Production management
Planning, controlling and monitoring production within a project, including the processes and resources required to produce construction services. The aim is to carry out production efficiently and to a high standard of quality.

Productivity
Ratio of the result (output) to the resources used (input). Implies that the goal is achieved efficiently and effectively.

Efficiency
‹Doing things right›.
Efficiency asks whether something is done with as little effort as possible.

Effectiveness
‹Doing the right things›.
Effectiveness asks whether the goal has been achieved.

7.2 Information management

Asset
Element, thing or entity that has a potential or actual value for an organization. In this context, asset stands for a structural asset (building). Structural assets include buildings, bridges, roads and process plants.
SN EN ISO 19650-1:2018

Attribute
In the definition of buildingSMART International or IFC data structures, there are different types of attributes that are used to describe information within an entity (e.g. a building element). An attribute is a unit of information within an entity that is defined by a specific type or by a reference to a specific entity.
There are three types of attributes:
- Direct attributes
- Inverse attributes
- Derived attributes

ISO 10303-11:2004, clause 9.2.1

Entity
English for entity. Logical functional unit, e.g. door/window
According to BSI: Information class defined by common attributes and restrictions
ISO 10303-11

MVD
The ‹Model View Definition› is a machine-interpretable definition of an information exchange request that is bound to one or more defined standard information schemas. Rules on how much of the entire IFC-schema is exported and in what form.
SN EN ISO 29481-1:2017, 3.16

Property
Represents the data field for defining a property of an entity in the IFC-schema. Properties are direct attributes that designate specific features of an entity to describe or characterize it in more detail. The characteristics are usually supplemented with values and units.

Pset
The ‹PropertySet› are property groupings in the IFC-schema that are comprehensible for both humans and algorithms within programming languages. Since each property can be measured differently and the values can therefore differ, specific properties of building products are increasingly provided via data dictionaries, where reference is made to the respective test standard.

Unit
Represents the data field for the value of a property in the IFC-schema, e.g. mm, m^2, l, kg. Refers to the unit of measurement or the context in which a certain property is measured or expressed. For example, dimensions can be specified in meters, weight in kilograms or costs in a specific currency unit (e.g. euro or US dollar).

Value
In IFC, value is the value that a property can have. Values are used to represent measurable properties of building elements, e.g. dimensions, weights, costs, quantities and performance parameters.
Concrete numerical or textual expression of a specific property of an entity. For example, the width of a wall could be specified as the value ‹3 m› or the material of a door could be specified as the value ‹wood›.

Boolean
Binary attribute type: true (true) or false (false)

Enumerated
An attribute type where the possible values are derived from a predefined list (enumeration). This restricts the selection of values to a fixed set, ensuring consistency and standardization. It can, for example, be represented as a drop-down menu.
ISO 10302-11:2004, 8.4.1

7.3 **Data** classifications and structures

Data
Example:
Entity: Batten
Attribute width/value: 30/unit: mm
Attribute height/value: 50/unit: mm

Data model
Generic, data-based description of a physical object.

Data schema
Logical structure with the definition of what must be described and documented and how and where. IFC, for example, is a data schema.

Building data
Describe the properties and composition of building materials, e.g. material types, material thicknesses, colors, textures and manufacturer information

Component data
Describe the properties and composition of components, e.g. component types, component thicknesses, component properties.

Material data
Describe the properties and composition of building materials, e.g. material types, material thicknesses, colors, textures and manufacturer information

Geographical data
Used to capture and display information about the location of buildings and construction projects and surrounding topographical features.

Geometric data
These data types represent the geometric properties of building elements, such as points, lines, surfaces and volumes. They are often used to describe building models (e.g. BIM models).

Performance data
Describe the performance and functionality of building elements, e.g. energy efficiency, building physics data, load-bearing capacity and fire protection classifications.

Logical element
Refers to an identifiable and distinguishable object or concept within the context of a building or building project information. Entities can be, for example, building components such as walls, windows, doors or more abstract concepts such as rooms, materials or building projects themselves. Each entity has certain properties or characteristics that describe it.

Ontology
An ontology is a structured model that describes concepts and their relationships within a specific area of knowledge. In computer science and knowledge management, an ontology helps to systematize information and enable a common understanding between different systems or users. Ontologies are often used in artificial intelligence, databases and the semantic web to present data in an understandable and machine-readable way.

System data
Describe the properties and composition of building systems, e.g. system types, system functions, system properties.

Administrative data
Includes information on the management and organization of construction projects, e.g. project structures, responsibilities, budgets, approvals and contract data.

Temporal data
Refer to points in time, time periods or schedules in connection with construction projects. They include time stamps, dates, schedules, construction times and time dependencies of activities.

7.4 Data logistics

AIDC
‹Automatic Identification and Data Capture›. AIDC-systems are technologies used to automatically identify, capture and store data without the need for manual input. These systems are commonly used in logistics, manufacturing, healthcare and many other industries to optimize processes, reduce errors and increase efficiency.

CDE
‹Common Data Environment› is a shared platform for exchanging all relevant information for a project or asset.
ISO 19650

IDS
‹Information Delivery Specification› is a computer-interpretable document that defines the requirements for model-based data exchange. It specifies which objects, classifications, properties, values, and units must be included in the information model and allows software tools to validate IFC files through automated processes.

Data Dictionary
Data dictionary. The basis for naming the data with machine-readable identifiers so that they can be provided and requested in a decentralized manner.
Each entity and each attribute has a language-independent ID. This makes information machine-readable and interchangeable across languages.
ISO 12006-3:2022, 3.1

PDT
‹Product Data Template› builds on data dictionaries. It is a structured template for product data (selection of properties and units without values) designed to provide information about the characteristics of construction objects in a machine-readable format and to enable data exchange.
[5]

PDS
‹Product Data Sheet› builds on the PDT. It is a document that provides specific information, properties, and technical details about a product. It facilitates clear communication between manufacturers, planners, and users and supports decision-making through standardized and structured product information.
[5]

DPP
‹Digital Product Passport› builds on the PDS. The data is accessible via a unique identification (data carrier). A digital record, based on the European Sustainability Product Regulation (ESPR), that contains standardized, detailed information about a product throughout its entire lifecycle. It includes relevant technical data and information about basic requirements in construction and circularity. The DPP aims to enhance transparency, support circular economy practices, and ensure compliance with regulations across industries.

7.5 Identification

UID
‹Unique ID› is the umbrella term for all identification systems such as GS1, GTIN or GUID.
ISO/IEC 15459-1:2014

GS1
‹Global Standard 1› is an organization that sets standards for a common language of business, i.e. a global consumer goods language Global Standard 1. An international, non-profit organization that develops standards for the identification, capture, and sharing of data to improve processes in global supply chains and various industries. Well-known standards include barcodes and GTINs (Global Trade Item Numbers).

GTIN
‹Global Trade Item Number› is a globally unique identification number for trade products, defined by the GS1 organization. It enables the unique identification of products and serves as the basis for barcodes and other automatic identification systems. Information can be directly derived from the code.

GUID
‹Globally unique identifier›, also known as Universally Unique Identifier (UUID). A globally unique identification number used to uniquely identify objects, files, records, or other elements in digital systems. It can be created decentrally while still ensuring its uniqueness, making it ideal for distributed systems. GUIDs are commonly used in software applications, databases, and information systems to avoid identifier collisions.

7.6 Information management

Identifiers
Unique identifiers, which consist of numbers, letters, symbols, or a combination thereof, and serve as keys to access specific data or information. They are important in communication and logistics to uniquely identify and distinguish objects, elements, or information within a system.

Information management
The systematic planning, creation, collection, management, storage and distribution of project-related information. The aim is to provide all those involved with the relevant information at the right time and in the right format to support the success of the project.

Information model
A structured dataset that contains subject-specific information and specific values related to buildings, organized within a digital data model.

Interoperability
Refers to the ability of different, independent systems to work together seamlessly and exchange data efficiently without special adaptations. This usually requires compliance with common technical standards to ensure compatibility.

LCA
‹Life Cycle Assessment› is a method for calculating and assessing the impact of a process, product, service, company or even an entire economy on the environmental balance sheet/life cycle assessment.

LOIN
‹Level of Information Need› describes the depth of information need.

7.7 Information management structure according to SN EN ISO 19650-1:2018

AIM
‹Asset-Information Model› is an information container or digital building model for the operation and management of a building. The content is specified by the client's Asset Information Requirements (AIR). Information already contained in the PIM is transferred to the AIM and supplemented or specified where necessary.
Section 3.3.9

AIR
‹Asset Information Requirements› are information requirements relating to the operation of the asset. They describe and define the information required by the client for the operation and management of buildings. The individual information requirements answer the questions of why, when, who and what, including any acceptance criteria for the provision of information. An information delivery consists of geometry, alphanumerics and/or supplementary documentation, see also Level of Information Need. The information requirements of the AIR are transferred to the Exchange Information Requirements (EIR) and ordered on a project-specific basis.
Section 3.3.4

BIM
‹Building Information Modeling› stands for a shared digital representation of an asset to support planning, construction and operational processes as a reliable basis for decision-making. Part of the BIM method, which involves the creation and management of digital building models including the physical and functional properties of a building or site. The digital building models represent an information database for the building or site and are a reliable source for decisions throughout the entire life cycle, from strategic planning to demolition.
Section 3.3.14

EIR
‹Exchange Information Requirements› are information requirements in connection with an information request. Collect the transferred information requirements from OIR, AIR and PIR into a clear and coherent set of requirements of the information requester. Together with the actual project order, the EIRs form the content of a submission and are answered by the providers in the pre-appointment BEP.
Section 3.3.6

OIR
‹Organization Information Requirements› are information requirements in relation to organizational goals. They describe and define the information that is necessary to achieve overarching strategic goals and to manage and make decisions within an organization. The individual information requirements answer the questions of why, when, who and what, including any acceptance criteria for the provision of information. An information delivery consists of geometry, alphanumerics and/or supplementary documentation, see also Level of Information Need. The information requirements of the OIR are transferred to the Exchange Information Requirements (EIR) and ordered on a project-specific basis.
Section 3.3.3

PIM
‹Project Information Model› is an information model for the deployment phase (planning to realization). Information requirements in relation to provision. An information container or digital building model consisting of geometric and alphanumeric information as well as supplementary documentation for the planning and construction phases of a building. The content is specified by the sum of the information requirements of all project participants. Where necessary, information from the PIM is transferred to the Asset Information Model (AIM). Note: In this context, asset stands for a structural asset (building).
Section 3.3.10

PIR
‹Project Information Requirements› are information requirements for the deployment phase (planning to realization). Information requirements relating to the provision of an asset. Describe and define the information that is necessary for the planning and realization of buildings for the client. The individual information requirements answer the questions of why, when, who and what, including any acceptance criteria for the provision of information. An information delivery consists of geometry, alphanumerics and/or supplementary documentation, see also Level of Information Need. The information requirements of the PIR are transferred to the Exchange Information Requirements (EIR) and ordered on a project-specific basis.
Section 3.3.5

7.8 Project management

User agreement
The user agreement consists of a description of the client's usage and protection objectives as well as the basic conditions, requirements and regulations for the project planning, execution and use of the building.
The user agreement ensures that the requirements defined in the project specifications are actually implemented in the finished building. This module deals with the technical and practical aspects of using the building and ensures that all user requirements and wishes are met. A clear and binding usage agreement and the definition of target and limit values play a key role in ensuring that the building meets the expectations and needs of its users (project specifications).
SIA 112

Project alliance
Organizational model between the client and a realization partner or several realization partners for the purpose of implementing a construction project in partnership according to previously agreed basic principles for joint, cooperative project realization.
SIA 2065, 2024

Project definition
Defines the project objectives, the benefits and the framework conditions for the project. It is the initial cornerstone of every construction project. It is drawn up by the client or their representative, the building owner. The client defines the most important and fundamental objectives, functions and framework conditions of the project, what benefits the building should have for those involved and which framework conditions must be taken into account. Economic, ecological and social aspects are included to ensure a comprehensive understanding of the project requirements. The project specifications, the project manual and the usage agreements refer to the project definition.
SIA 4011, 202_i.A

Project manual
This is where the structural and procedural organization and the responsibilities for carrying out the construction project are defined. The project manual regulates the organizational aspects of project execution. This includes the structure of the project team, the execution within the individual project phases, the expected results and the definition of responsibilities. The scope and level of detail can vary depending on the type of project. In addition to organizational matters (processes, milestones, execution model, organization, functions, bodies, tasks, competencies, responsibilities, committees, etc.), the principles of controlling, reporting, project risk management, project change management, project-specific quality management, information and publicity concept, etc. must also be defined. The project manual is drawn up by the contractor in accordance with the clients specifications. A clearly defined project handbook helps to ensure that everyone involved knows their tasks and responsibilities and that the project runs smoothly.
SIA 4011, 202_i.A

Project specifications
Contains the functions, properties and requirements of the building to achieve the target values specified in the project definition. The project specification is a central document that describes the detailed requirements for the construction object. The project specifications are drawn up by or on behalf of the client at the start of the project (in phase 2 in accordance with SIA 101). This includes the functions, properties and requirements (e.g. technologies, systems and standards) of the building and facilities. It serves as a reference point for all project participants and ensures that the end product meets the specified requirements. The project specifications are specified and updated in phases and checked for conformity with the project definition.
SIA 101

T-model
Task model or transaction model. T-shaped schema for describing the goal, output (results), work steps and input (basics) for a specific task
[15]

Use Case
‹Use case› [..] describes [..] processes [..] according to defined requirements for [..] fulfillment of one or more objectives.
[5]

VDC
‹Virtual Design and Construction› is a project management method., developed by Standford University. Aligns project management consistently with the projects and uses the relationship triangle of people-process-technology.

7.9 Contracts

LHO
Swiss service and fee regulations: Contract and agreement standards of the SIA for the construction planning industry.
SIA 101 ff

preBEP
The ‹Pre-Appointment BIM Execution Plan› is the basis for clarifying the order. For the quotation and commissioning of the project execution team, usually part of the contract. This is where the provider answers the project-specific planning and information requests and demonstrates its capabilities in dealing with the BIM method. The decision-relevant content to be answered must be kept objectively verifiable and/or measurable by the client and marked accordingly. The aim is to create mutual clarity between the party requesting the information and the provider regarding the key points of information management and the provision of information prior to awarding the contract. Further clarifications and additions will be made in the BEP after commissioning.
SNG CEN/TR 17439:2020, 5.3

BEP
The ‹BIM Execution Plan› is the project manual to organize a BIM project. Plan that explains how the information management aspects of information delivery will be carried out by the delivery team. It describes in detail the project-specific collaboration regarding planning and information delivery based on the pre-appoinment BEP. Essentially, it is about how the client's information request and the information requirements of the other project participants are met by means of information deliveries. The information deliveries are organized and transmitted in so-called information containers. Coherence between the information suppliers involved must be ensured by a lead authority. The BEP is checked for validity and updated as required, but at least in phases.
SN EN ISO 19650-1:2018 Clause 3.1.3.1

Individual contract
Regulates the relationships between individual parties.

Alliance agreement
Contract governing a project alliance. Innominate contract similar to a contract for work and services for the purpose of providing services in return for payment for the planning and realization or only for the realization of construction projects.
SIA 2065, 2024

Multiparty contract
The multi-party contract regulates the relationships between all alliance partners (e.g. client, architect, specialist planner, contractor).
SIA 2065, 2024

IPD
The ‹Integrated Project Delivery› aims to bring all project participants together from the outset in order to improve the efficiency and effectiveness of project execution. Common goals are defined to share risks and rewards in partnership.

Design Build
Often as a total contractor model in construction project management: Involvement of relevant implementation companies in the design phase to jointly develop structural solutions with the planners.

7.10 Classifications

eBKP-H
Element-based construction cost plan for building construction. Standard for element-based cost calculation in building construction.
SN 506 511

IFC
The ‹Industry Foundation Classes› is an open data schema for data exchange in the construction industry and facility management.
ISO 16739-1:2024

7.11 Organizations

BIMwood
‹Innosuisse project 42874.1-IP SBM› This project ran from 2020 to 2022 and aimed to create a conceptual basis for a digitally integrated overall process in timber construction.
[15]

CEN
The ‹European Committee for Standardization›, which is a private, non-profit organization whose mission is to promote the European economy in global trade, ensure the well-being of citizens and promote environmental protection. CEN is responsible for European standards.

bSI
‹buildingSMART International› is a UK-based not-for-profit organization dedicated to the development and promotion of open digital standards for the construction and real estate industry. It works closely with a global community of chapters, members, partners and sponsors to enable more efficient collaboration and interoperability across the building lifecycle through open BIM processes.
buildingSMART International

bSDD
The ‹buildingSMART Data Dictionary› is an online service that contains classifications and their descriptions of properties with their units and translations. The bSDD enables the linking of all contents of the database to an ontology. It offers a standardized workflow to ensure data quality and information consistency.
buildingSMART International

ISO
The ‹International Organization for Standardization›.

STE
‹Swiss Timber Engineers› is an association of timber engineers and specialists for wood in Switzerland, in existence since 1991.

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