Building Information Modeling (BIM)
in Electrical Engineering

WSCAD White Paper
Building Information Modeling (BIM) promises to make engineering in the building sector much more economical over the entire life cycle of objects. From planning to execution, commissioning and operation, right through to reconstruction or dismantling. Planning processes are optimized, and gaps in the planning are more easily recognized. All project managers benefit from BIM through a massive reduction of disruptions in the construction process. When all the tools available can access and understand the same database, a consistent and system-independent data exchange is possible. This ensures reliable scheduling and a constantly updated cost overview. Collisions, bad planning, delays and cost explosions - all such issues are a thing of the past.

In addition to this, with consistent ongoing development, the data pools of individual Smart Buildings grow together to form entire Smart Cities.

This is truly an exciting time for the experts within building automation regarding the idea behind BIM. However, it is still a long way off to perfection. Because even just the definition, adoption and implementation of generally valid international standards takes time. While the statics and technical building equipment (TGA; German abbreviation for „technische Gebäudeausrichtung“) are already well advanced, BIM is still in the starting blocks when it comes to definitions for building automation.

This white paper performs a reality check about what opportunities BIM really offers and what has already been achieved. Which user groups benefit from BIM, which tools are used in each case and which trades are involved. This will be clarified in the white paper with examples.

In addition, it also provides an overview of which bodies are relevant to BIM - and what they are responsible for.

**BIM - An Overview**

Building Information Modeling (BIM) is a computer-aided, multi-dimensional and object-oriented method for the design, manufacture and operation of buildings (of any size) using a software. In the first step, a virtual three-dimensional (3D) building model with all building information is generated. In the second step (4D), performance data are supplemented and linked to determine the costs in the third step (5D).
The basis for the integration of the individual processes lies in a consistent, virtual building model that covers all phases of planning, construction and use. The model includes, in particular, the spatial structure as well as all components and properties. The facilities, equipment and costs are likewise reflected here.

BIM includes all trades, technical departments and the software tools used. Internationally defined and accepted data models and formats are mandatory for this purpose.

While the use of BIM is already established or required and promoted by the legislature in the United States, the United Kingdom and the Scandinavian countries, the situation in the German-speaking world is different. In Germany, Austria and Switzerland, the introduction of the integrated planning method is still in its infancy.

**BIM - The Benefits**

The improved data synchronization should bring an increase in the productivity of the planning process and improved risk management with regard to costs, deadlines and quality.

*BIM runs as a process through the entire life cycle of buildings*

The basis for this is the improved quality of data, since everything is maintained in a common database and constantly synchronized there. Furthermore, there must also be immediate and continuous availability of all current and relevant data for all the parties involved. The exchange of information between all planning participants must be a smooth process - over the entire life cycle of a building.

Fewer disruptions and less susceptibility to errors, greater transparency, earlier planning and cost certainty are desired by many participants and now is the chance to make it a reality. The one-time entry of data is sufficient - the same data does not have to be re-entered elsewhere. Process flows thus take significantly less time.

All stakeholders in a project can thus plan on the basis of a shared database independently of other software solutions. Consequently, Open BIM is not surprisingly seen as a digital revolution in the construction industry and the ideal method for project planning in the future with no better alternative. In all project phases, data breaches and loss of information due to interfaces are avoided.

**The Vision of BIM:**

- BIM data is available throughout the entire life cycle of a building
- Current and consistent documentation, easier acceptance and testing
- Cross-disciplinary parts lists, procurement and cost control
- “Centralized” project process instead of countless “peer-to-peer” connections
- Conflicts and collisions between the trades are recognized more quickly
- Better coordination and cooperation between the actors
- Earlier involvement of downstream, internal teams
- Cost optimization in operation, facility management and conversion
- Linking the digital model with the world of augmented reality

**The Seven Ds in the Context of BIM**

BIM guarantees at least a 5-dimensional view - even a 7-dimensional view of all processes is possible:

- 2D: Floor plans and the entire 2-dimensional building / project documentation
- 3D: 3-dimensional visualization and presentation of buildings and objects
- 4D: Scheduling - the entire building with all design and construction stages are connected in real time with a data model for scheduling
- 5D: Costs - all design and construction sections and the entire building are assigned costs
- 6D: Ecological and economic sustainability of a building
- 7D: Building Life Cycle / Facility Management Information – Analysis and correction proposals of all building data during the operational phase (what, who, when, where, how much ...)

*Idea* *Planning* *Execution* *Commissioning* *Acceptance* *Operation* *Reconstruction* *Dismantling*
The Involved Trades

- Civil engineering / structural engineering / doors, windows / facade / roof
- Technical building automation (TGA, German abbreviation for „Technische Gebäudeautomatisierung“):
  - HLSK (HVAC and sanitation: heating, ventilation, air conditioning and sanitation)
  - Electrical installation (high and low voltage)
  - Building automation / Programming (MSR: measurement and control technology)
  - Security technology, media and data technology / TC
- Interior fittings / equipment
- Outdoor facilities

... and subsequently

- Maintenance (CMMS: Computerized Maintenance Management System)
- Facility Management (CAFM: Computer Aided Facility Management)
- Procurement / ERP (Enterprise Resource Planning)

BIM models describe only the devices and structures in a building and not how they interact, which would be required in building automation. For example, there is a control cabinet as a device in 3D. But what happens in there is not currently part of BIM. The electrical installation with tracks, switches and lamps is shown in BIM - but not their operation.

Barriers to the Introduction of BIM

In the mid-1980s, Digital Equipment, Intel, and Xerox defined the industry standard Ethernet V2 for wired high-speed data transmission over local area networks. This was standardised internationally under 802.3 by the Institute of Electrical and Electronics Engineers. A decade later, 802.11x was adopted for wireless communication via radio in the form of WLAN and Access Points. Today, regardless of the manufacturer, all data terminals worldwide communicate with one another without any problems based on these standards. Without them, today's Internet would be unthinkable and impossible. However, their development took over a decade - and compared to the complexity of buildings, these are extremely simple standards.

It is therefore reasonable to assume that just the coordination requirements alone to cover the entire life cycle of complex buildings would be immensely high. Against this backdrop, the idea of the German Federal Government, according to which only BIM-capable planning documents may participate in public tenders from 2020 onward can be deemed questionable.

The most important barriers to BIM are:

1. The question of costs: From the builder's perspective, there is the requirement that the costs be borne by the stakeholders involved. The stakeholders return this topic towards the builders. Special case - Austria: The planners have already been obliged to pay the costs for several years.

2. The standardization question: Probably the biggest barrier is creating a common standard for data exchange. The shared exchange must be done via an Industry Foundation Classes (IFC) interface, so Open BIM should have no problem with it. This interface does not yet comprehensively describe all aspects and functions in a building.

3. The ownership question: Who manages the data and operates the servers, what happens to the data after the completion of the building - such questions have not yet been clarified. For example, the question of how access to the data is granted to the project participants such as architects, builders and installers: via a cloud - or should everything be compiled together at the end? Even the occupational fields for BIM managers, coordinators and modelers have yet to be established.

4. Responsibility for infrastructure: It is still unclear who provides the infrastructure and who pays for it.

5. Privacy: Especially in public projects, the issue of data protection is the focus. For a cross-disciplinary, real-time BIM process, appropriate prerequisites and standardized regulations are required.
Software for Building Optimization

Over the entire life cycle of buildings, project participants use various software applications:

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<th>Specialists and technical departments</th>
<th>Software to be used</th>
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| Architect                             | - CAD, electrical CAD  
- ERP  
- Calculation tools |
| Civil engineers                       | - CAD, electrical CAD  
- ERP  
- Documentation |
| Fire protection                       | - CAD, electrical CAD |
| Electricians / installers             | - CAD, electrical CAD  
- Calculation software for network design |
| Facility Management                   | - CAD, electrical CAD  
- CAFM |
| Building automation specialists       | - MSR software  
- ERP |
| Maintenance                           | - CAD, electrical CAD |
| Design managers                       | - CAD, electrical CAD  
- ERP |
| Project managers                      | - Project management software  
- CAD, electrical CAD  
- ERP  
- Documentation |
| Sanitation                            | - CAD, electrical CAD  
- ERP |
| Structural engineers                  | - CAD, electrical CAD  
- Calculation software |

Due to the increased number of processes, different approaches have developed. „Little Closed BIM“ is the digital illustration of a building section with a specific software. This corresponds to the current state of the art, in which each specialist separately processes a digital solution. On the way to Big Open BIM, interdisciplinary software solutions are emerging from technical disciplines.

ERP software is used by the individual stakeholders within their company. There are numerous providers who often specialize in the interests of an industry. The exchange of service descriptions is often done using the GAEB format (GAEB is the German abbreviation for „Gemeinsame Ausschuss Elektronik im Bauwesen“, i.e., the „Joint Committee for Electronics in the Construction Industry“)

PLM software is not used for building design. It shows its strengths only in internal company processes. Due to the high complexity in the building design process, the integration of many participants with different technical backgrounds and from various companies requires open solutions across all borders. This part will be taken over by BIM in the future.
Cost Analysis of Buildings Over their Useful Life

In a cost-benefit analysis, the effort for planning and creation is slightly higher than in the previous conventional approach. However, decisive cost advantages arise in the operating phase of the buildings, and the longer this occurs, the higher the savings.

Scenario: How BIM Works

In classical construction design, an architect creates a design and draws it using a CAD system. The plans are presented to specialist engineers, fire safety experts and authorities. For costing, a quantity determination is created based on the drawings. This requires a combination of the geometries with qualitatively and monetarily defined service components, so that the individual quantity details can be summed up in service items or imputed partial services.

If a change in the planning occurs, the drawings must be changed, the quantity determination must be adjusted, and all parties involved receive updated drawings and must compare them with their specialist planning. This increases the overhead for the coordination effort and workload considerably and includes many possibilities for error.

The process can be significantly reduced with BIM: The architect or specialist planner makes changes directly to the project file or model. The BIM coordinator merges the individual planning into an overall model and, in addition to quality assurance, regulates the exchange of information between all parties involved. The changes are available to all participants as a drawing as well as a data package. Masses and quantities that serve as the basis for costing, for example, are automatically reconciled. If, for example, the architect changes the number and description of the doors in a building directly in the virtual building model due to changes in the floor plan, the door list changes automatically and, if linked correctly, the immediate impact on the costs and the time schedule can be immediately recognized.

Example of an Elevator and Escalator

Every component in the building is characterized by certain specifics. For an elevator or an escalator, these include:

- Mechanics, dimensions and weight
- Electrical connections
- Symbols and 3D sketches and 3D data for different software planning tools

The involved departments / trades and their topics are:

- Mechanical engineering (manufacturer, technical data, documentation, revisioning, approval, ...)
- Architecture (technical data, dimensions, weights, CAD data, cabin structure, cable guide, door mechanism, etc.)
- Building automation (data points, scheme, control)
- Electrical installation (cabling, schematics, control cabinet, etc.)
- Facility Management (model, version, manufacturer, supplier, tradesman, etc.)
- Maintenance (maintenance contracts and service manuals, guides, schematics and circuit diagrams, documentation, test and acceptance protocols and reports, spare parts, ...)  

This requires the different systems to be seamlessly interlocked. A leading system does not have to exist - so long as everyone „understands“ one another. To do this, the current IFC interface must be used by all in the same way. However, this is currently not yet the case.
Committees - Who Defines What?

BIM needs a strong initiative from all those involved in building design and management. Consequently, several committees have been formed, within which there are multiple participating actors in some cases:

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<th>Committee</th>
<th>Function and task</th>
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| buildingSMART | - The international organization aims to establish open standards (Open BIM) for information exchange and communication based on Building Information Modeling.  
- buildingSMART has developed a basic data model - the Industry Foundation Classes (IFC) for model-based data exchange in construction.  
- buildingSMART maintains a database of all programs that support IFC (as per their own information) and offers all software manufacturers a certification program for the independent quality control of their IFC interface. |
| Federal Ministry of Transport and Digital Infrastructure (BMVI) | - Demand for a phased plan for the introduction of modern, IT-supported processes and technologies for the design, construction and operation of assets in the built environment.  
- Definition of contractual arrangements that explain the collaboration of the participants in the construction and demonstrate a team-oriented approach to the design process from a technical viewpoint. |
| International Organization for Standardization (ISO) | - ISO is the international association of national standards organizations and develops international standards.  
- ISO 16739:2013 is relevant in the context of BIM and specifies the data exchange. |
| Open-BIM-Initiative | - Open BIM is a global initiative of the international buildingSMART organization that is supported by an increasing number of software vendors.  
- The goal is to have a software-independent planning method for the entire construction industry. |
| Association of German Engineers (VDI) | - The VDI is Europe's largest technical and scientific association  
- It sees itself nationally and internationally as a spokesperson for engineers and technology, as a networker and designer.  
- The Coordinating Group on “Building Information Modeling” (VD-BIM; KK-BIM in German) focuses on the identification of policy issues as well as the preparation of statements and recommendations to the policy makers and relevant decision-makers.  
- Even the positioning within the international regulatory framework is dealt with by the VDI Coordination Group BIM. |
Possibilities for System-independent Data Exchange

Different formats and standards have already been presented by actors in the field of BIM. The most important are the following:

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| Change Coordination - BIM Collaboration Format (BCF) | - BCF is a "simplified" open standard XML schema that encodes messages to enable communication between different BIM software tools (Building Information Modeling)  
- It was developed for the transmission of specific information from larger building models, such as collisions |
| Industry Foundation Classes (IFC) / ISO Standard 16739:2013 | - The Industry Foundation Classes (IFC) are an open standard for the digital description of building information modeling in construction.  
- The IFCs are defined by buildingSMART International (bSI) and registered under the ISO Standard 16739.  
- Logical building structures such as windows, openings, walls, floors, buildings with the associated properties (attributes) as well as optional geometries are depicted. Among other things, complex 3D planning data with the associated components and descriptive attributes can be exchanged between building software systems. |
| Mapping of Terms - International Framework for Dictionaries (IFD) | - The buildingSMART Data Dictionary (bSDD) is one of the core components of the buildingSMART technology.  
- The bSDD is a reference library based on the IFD Standard that is intended to support improved inter-operability in the construction industry. |
| Process Standard - Information Delivery Manual (IDM) | - buildingSMART processes (IDMs) capture business processes and integrate them on an ongoing basis.  
- At the same time, they provide detailed information about the information that a user who fulfills a specific role must provide at a specific point within a project.  
- To further support the specifications for the exchange of user information, IDMs also suggest several modular modeling functions that can be reused during development to support other user requirements. |
| Process Translation - Model View Definition (MVD) | - Model View Definitions (MVDs) define the subset of the IFC data model that is necessary to support the specific data exchange requirements of the AEC industry during the life cycle of a construction project.  
- A model view definition provides implementation guidelines (or implementation agreements) for all IFC concepts (classes, attributes, relationships, property sets, quantities, etc.) that are used in a subset. |
| VDI Guidelines | - VDI 3805 Product Data Exchange in the Building Services (TGA): describes the format of the manufacturer data for the parts database  
- VDI 3814: Symbols in building automation  
- VDI 3813: Symbols for room automation |
**BIM - Current State of Affairs**

With BIM, the construction industry is facing its biggest organizational realignment. This is comparable to the breakthrough of CAD systems in the 1980s. The new planning method offers all project participants many advantages such as cost reductions, deadline security, better quality, timeliness and transparency of project data.

The currently defined information such as room sizes, wall thicknesses, windows and doors are available for a variety of purposes, such as calculations, BOM creation, or visualizations. The representation of the installed parts and components occurs in 3D (washbasins, radiators, ventilation ducts, cable trays or a heat pump). This also includes characteristic data (radiator performance data, dimensions of the ventilation duct, settings for air outlets or valves). Even complete documents such as assembly instructions, maintenance information or repair instructions can be linked as information with the components.

There are currently no definitions for important areas such as building automation / MSR (measurement and control technology), electrical engineering / schematics or electrical installation - these must be created successively.

The parallel planning of all project participants in a common BIM data model, where all changes are visible in real time – have not yet been realized. Often, this is the case in larger projects. However, even today, some BIM solutions enable relatively comfortable parallel model processing.

Until BIM can develop its full potential, there are still many tasks ahead that need to be accomplished first. However, immense benefits for the work of all project participants can be expected for the future. Even if, in view of the complexity of coordinating standards, a lengthy process can be expected until complete integration is achieved, BIM already offers a desired added value to users today.

**WSCAD und BIM**

With the WSCAD SUITE, WSCAD now offers a cross-disciplinary and integrated engineering solution across the six disciplines of electrical engineering, cabinet engineering, process and fluid technology, building automation and electrical installation on a single platform with a central database. The replacement of a component is immediately reflected in all the plans of all other disciplines. Captured data points are available in all other disciplines and can be assigned directly to the channels of a controller (DDC/PLC). This makes the WSCAD SUITE a “little closed BIM system” that comprehensively reflects the requirements of building automation.

WSCAD actively supports and accompanies Building Information Modeling (BIM). The company is committed to the rapid implementation of standards.

*Behind every good plan is a clever mind.*

*Behind ECAD it is more and more often WSCAD.*