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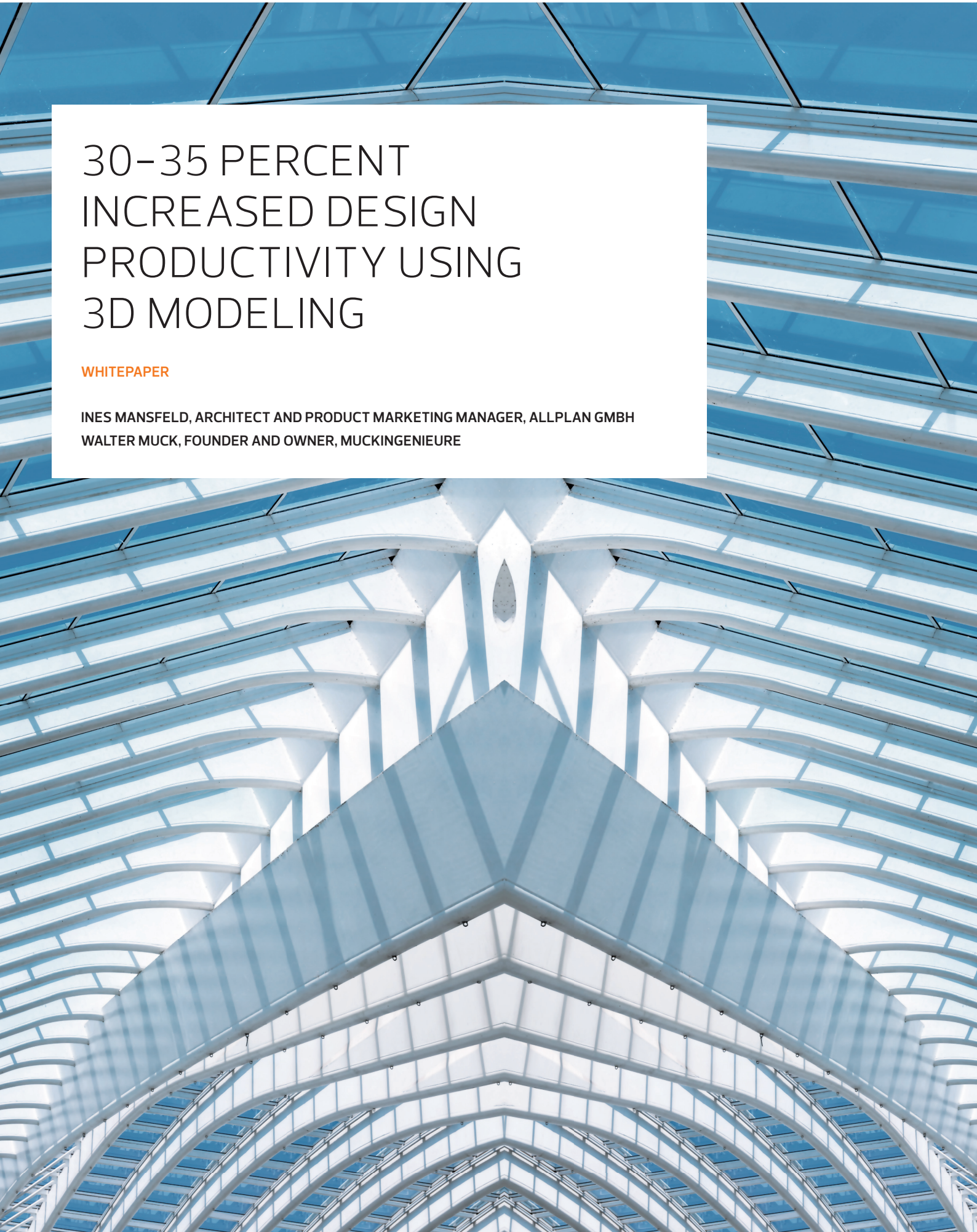

30–35 PERCENT INCREASED DESIGN PRODUCTIVITY USING 3D MODELING

WHITEPAPER

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Working in 2D means drawing lines, circles, hatchings, or fills. This is how it has always been done. Only, today, it is no longer done with ink and a ruler on the drawing board. First introduced in the mid-1980s, computer-aided design using CAD software has become increasingly popular in engineering and drafting offices. Drawing became more efficient: Functions like "copying," "changing," and "deleting" revolutionized everyday work. Technology and CAD software has developed rapidly since then, but the drawing methods of many engineers and designers has not. The CAD software is frequently still used like a digital drawing board. The reason for this is often the fear of an increasingly complex design process. But the opposite is true. The benefits of the 3D working method outweigh the disadvantages. In this white paper, you will see how 3D modeling benefits engineering and drafting offices, and how the engineering consultancy MUCKINGENIEURE from Ingolstadt has used it to increase productivity.

The main argument against transitioning to a 3D working method is that the effort it requires will negate any return on investment. However, it is forgotten that the extra effort involved in a 2D working method is also inefficient and costly.

The existence of a structural model accelerates subsequent steps, such as producing plans, views, sections, and details, creating the dimensioning and labeling, or running analyses. Furthermore, the effort required to check plans for consistency or ensure the quantities are correct is reduced to a minimum. Finally, a structural model can also be used for additional functions, such as bills of quantities, structural calculations, visualizations, assembly instructions, collision checks, or reviewing various design options. This eliminates the need to enter the same information repeatedly, identifies conflicts in the design phase, and avoids unnecessary queries from the building site. The conclusion is therefore that a 3D working method is economically advantageous for an engineering firm in most cases, regardless of the commission, project margin and additional fee.

MORE INFORMATION THROUGH THE 3D MODEL

Working in 2D means working based on elements. In this working method, a drawing is created solely from individual elements, such as lines, circles, and polylines. Line thicknesses, hatchings, and fills define which component is being handled. These definitions are regulated in standards so that every person involved can read the drawing. The elements themselves do not contain any information and have no relation to each other. A wall, for example, consists of only two lines. These lines alone tell you how long the wall is and whether it is a section. Information such as the height or material is linked to these lines. A 2D drawing is therefore an orderly collection of elements without any actual informational content. All other information must be added to the drawing using text and numbers. However, this "increased" information is only useful for a paper drawing. Except for printing, there is no other way to use the digital 2D drawing. Therefore, no additional information can be obtained. The effort that goes into creating a drawing is out of proportion with the benefits gained from it.

The 3D working method is component-oriented, which means the drawing does not consist of different lines, but rather of intelligent components. With the 3D working method, a wall is not just a wall on a drawing, it is also a wall in the 3D model. It is a component that contains a great deal of information that can be read through certain functions. This information contains general properties

(attributes), such as the wall thickness and height. This does not mean that all the information must be available in the early design phases, as is often feared. But the more extensive the additional information is, the more versatile and effective the 3D model becomes. When updated with information about the structure's physical properties, the 3D model can be used to create EnEv (Energy Saving Regulation) or sound insulation checks, for example. This way, the engineer can generate additional services from a service he or she has to provide anyway (creating the design), and can do so without much additional effort.

Once a library for standard components has been created, the design workflow can be significantly accelerated. Once defined, the standard components — enhanced with information — can also be used across projects and do not have to be re-created for each project. There are many opportunities for their use. Depending on the type of drawing to be created, the component information can either be placed directly next to the component as automatically generated text, or it can be issued separately as tables and other documents. This facilitates communication with design teams, clients, and contractors.

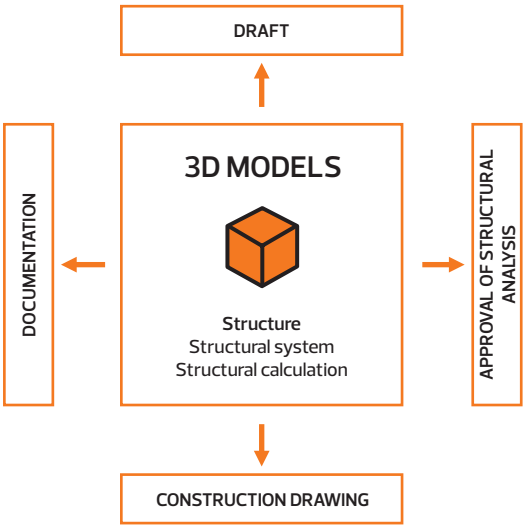
INCREASED EFFICIENCY WITH THE 3D MODEL

In the element-based 2D working method, the elements and drawings have no relation to each other. If changes are made, the elements need to be adjusted manually. For example, if a column or wall is re-dimensioned, lines must be moved, hatchings modified, and text may need to be changed — across all affected drawings. This means that even the smallest changes can become a task for the entire day. In addition, manually applying changes to all design documents is prone to error. This quickly becomes confusing with complex projects, especially when the design process is already at an advanced stage. All drawings and previously calculated quantities that are affected have to be identified. In addition to drawings, many other documents may need to be reviewed and adjusted as a result.

Several project team members often work on one project simultaneously. Design drawings are created and corresponding quantities are calculated by different employees, sometimes in different departments. In the event of corrections, all project members must be informed of the changes. This results in a potential for errors due to poor communication. This potential is particularly high in engineering and drafting firms that work with many part-time employees, or that rely on support from freelancers. The people concerned are not always present, making it difficult to coordinate and come to an agreement.

At some point, such processes are no longer covered by the remuneration. Manually updating the many design documents cannot be billed to the client, especially when it is not necessary and technology offers better solutions. The engineering or drafting firm then has to absorb the added costs, reducing profits.

It is much faster and — above all — safer to make a change in the 3D model, and then automatically generate updated documents from the model. The drawings and quantity calculations are updated in real-time, and all documents and drawings are immediately up to date and consistent. The updated drawings can then also be forwarded just as quickly.



Drawings and quantities are easily updated with the 3D model. This saves time during the project development and provides information to the clients, design teams, and contractors instantly.

MANY DRAWINGS, ONE 3D MODEL

At the end of each design phase, the engineer delivers plans (i.e. 2D drawings) to clients, building authorities, contractors, design teams, etc. This is either done in the form of folded paper plans, digitally as a PDF, or — in most cases — both.

Although technology — in this case, CAD programs — continues to develop constantly, 2D drawings are still the norm. Among other reasons, this is partly due to building permit procedures, where the submission of paper plans is still standard. There is therefore no compelling need for engineers to switch to a 3D application. One exception is projects using CNC-made formwork elements, where the geometry of the structural model is implemented directly without using drawings as an intermediate step. This means that drawings are still being created. Different line types and thicknesses are used depending on whether components are to be visible, cut-out, or hidden in the drawing. In most cases, the line thicknesses, hatchings, and fills depend on the material. Other differences result from the scale and drawing type. Unlike general arrangement drawings, components that do not consist of concrete are usually hidden; for example, in reinforcement drawings. The line thicknesses are reduced, but the reinforcement is shown.

The rules for the correct drawing presentation can be complex and elaborate. They are usually embedded in local standards and rely on a certain amount of experience to implement. To a certain degree, a scale-dependent representation can also be controlled with element properties — such as line or hatching properties — when working with 2D CAD software. However, the 3D working method offers more possibilities. Lines, hatchings, fills, etc. can be defined so that they are not only shown relative to the scale, but so that they are also shown differently depending on the drawing type. Once this component information has been stored in a design library, completely different drawings can be created with just a few clicks.

ENHANCED TRANSPARENCY WITH THE 3D MODEL

The advantages of digital project development and design are obvious. A continuous exchange of data between all project team members ensures that every discipline is working with a consistent design at all times. This even works across countries and languages. Changes can be shared instantly. This is also true of the 2D working method. However, collisions or spatial problems can be easily identified visually via the 3D model, without creating ceiling designs, sectional views, or detailed drawings. Installation or maintenance scenarios can be verified in any design phase by using 3D representation. The supporting structure can be evaluated in conjunction with the building design, and all building services and options are easier to assess.

A 3D model can even show very complex geometries, which is very difficult or even impossible when working conventionally in 2D. Organic shapes or sophisticated structures can be easily understood by using different visualization methods and views. This visual inspection often uncovers many errors without needing to resort to detective work by manually comparing plans. This avoids unpleasant surprises on the building site, especially when precast elements are installed or prestressed concrete is used.

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SMOOTH BUILDING PROCESS WITH THE 3D MODEL

The 3D model offers major benefits to engineers besides just designing the structure. The 3D model can also simplify the planning of the building process. A precise building site layout forms the basis for an on-schedule and on-budget construction project. Urban or complex building sites in particular require logistically sophisticated and precisely timed planning, ideally before the works break ground. Storage areas, equipment, material, containers, building site power, etc. generate costs daily on a building site. The more information that is used in the production of the design, the more accurate and predictable these costs are. A plan-based building site set-up in 2D makes it difficult to understand the on-site conditions. The lack of visualization of highs and lows quickly leads to clashes within the site or with elements in the site environment. Earth excavation and component loading options can be simulated using a 3D model (consisting of the 3D structural model, the 3D environmental model, and the 3D objects of the building site layout) and checked with the respective contractors. Simple three-dimensional solid bodies can be used to show work areas of people, machines, and scaffolds so they can be optimized in the building site plan.

However, a precisely planned project is not the only factor that can positively influence the building process and thus contribute to lower costs. The use of precast elements or CNC-made formwork elements can significantly accelerate the building process. This prefabrication is sometimes essential with very complex supporting structures. It all depends on precision. The collision-free 3D model is used to send quality-tested data directly to

Walter Muck, founder and sole proprietor of MUCKINGENIEURE, dedicated himself to using innovative, future-oriented technologies in structural design from the outset.

prefabrication. This can usually be directly imported into the production machines. This accelerates the production time and avoids errors from system breaks.

BEST PRACTICE: STRUCTURAL DESIGN 4.0 BASED ON A 3D MODEL

The example of MUCKINGENIEURE from Ingolstadt shows that the transition from 2D to 3D, and even to BIM, can be economically attractive for an engineering consultancy. The engineering firm was founded in 1996 and dedicated itself to using innovative, future-oriented technologies in structural design from the outset. Walter Muck, founder and sole owner of MUCKINGENIEURE, recognized the substantial added value provided by 3D working early on, and for the past 20 years has transitioned from pure 3D modeling to BIM. Today, MUCKINGENIEURE benefits from increased design productivity, an expanded portfolio that includes structural engineering services, and enhanced efficiency when estimating and tracking the steel mass, which is taken directly from the digital structural model.

The office began with complete 3D design in 1997, but had to stop due to insufficient technology. Nevertheless, the foundation was laid, and it inspired belief in the potential of 3D modeling. The renewed attempt at complete 3D design was begun with the commissioning of their design services for the project "New construction of an administrative building for E.ON in Zolling near Freising." The building had an extremely complex geometry with a complicated supporting structure: a sloping building contour, inclined walls, split levels, and curved soffits. A collision-free representation of this complicated building geometry was only possible with a digital 3D model. At the same time, this 3D model could be used to show important reinforcement details, thereby significantly simplifying the structural design. Since then, MUCKINGENIEURE has designed every project with a digital 3D model, regardless of the scale.

Instead of drawing lines, they work with intelligent components with assigned attributes. A predefined library greatly facilitates the model creation. The line type and thickness are automatically chosen to be true to the scale. Predefined drawing layouts make general arrangement and reinforcement plans appear as desired and significantly increase the quality of the design documents. At the same time, this also defines the office standard. Everything is derived from the 3D model. That means that changes are only made once. The design itself does not change for the team. Quite the contrary. The reinforcement is placed in the plan, section, and elevation views resulting in consistent reinforcement placement in the 3D model. This is how Walter Muck achieves a 30 to 35 percent higher design productivity in his office.

30–35 %

PRODUCTIVITY INCREASE THROUGH 3D DESIGN

„Designing is often easier with the 3D model and we achieve a productivity increase of approximately 30 to 35 percent."
Walter Muck

It is possible for MUCKINGENIEURE to derive all masses from the 3D model with their design library and predefined components. Due to the further efficiencies gained from using the tendering software NEVARIS, the office was able to expand its portfolio to include building services engineering, offering its clients more value. MUCKINGENIEURE has optimized its design library and predefined components to

the extent that even the steel mass estimation and tracking are done directly from the 3D model. Muck estimates the increase in efficiency achieved to be 85 to 90 percent. Structural and physical checks are another new business area that resulted from using a 3D model. Effective EnEV (Energy Saving Regulation) and sound insulation checks are now also created with the 3D model, which has been expanded to include structural physical properties.

"If a 3D model already exists in the office, then it is only logical to fill this model with structural physical data, thereby creating effective EnEV and sound insulation checks." Walter Muck

Because of this constant continued development, the step to BIM was easy for MUCKINGENIEURE. When designing supporting structures, the team relies on Allplan Engineering, supplemented with the design library Allplan IBD (intelligent building data.) The 3D model – updated in Allplan with all necessary attributes – is provided to all those involved in the design via the BIM platform Allplan Bimplus, thereby significantly improving communication. The engineering model is compared with the models from the architects and specialist designers and questions or issues about the results are communicated and documented via BCF files. The design is discussed online and processed directly on the model. The visualization of supporting structure options is easy for the client.

But more than just the communication is facilitated. The BIM working method offers major advantages throughout the entire collaboration with the project team members. The online or cloud-based software solutions make it possible for employees at different locations to effectively work on a project, even from a home office. However, different offices can also collaborate on projects this way. It is an excellent way for smaller offices to keep pace with the larger ones.

Walter Muck sees competitive advantages in the BIM working method in terms of attracting, retaining, and motivating employees. His experience shows that young employees who grew up with smartphones and tablets are very quickly enthused about the BIM working method. In addition, he has learned that employees generally recognize that offices that adopt the future-oriented BIM working method make a contribution to securing their jobs. Because the future is digital – of that Walter Muck is certain.

E.ON power plant in Zolling
Administrative building in an
"inclined position"

CONCLUSION

Engineers should take advantage of the technological opportunities to remain competitive. The information and evaluation options offered by a 2D drawing are less and less suitable for meeting today's design needs, especially with the increasing pressure for shorter project timescales. Exchanging information anytime, anywhere is standard today. Only those companies who adapt and can provide the necessary information as and when required remain competitive. There is no consideration for outdated and slow processes.

It is not only the demands of clients that are increasing, but also those of junior staff. Young engineers today choose their employers carefully.

Remuneration is often not the main criterion for choosing or rejecting an employer. This generation grew up in the digital age. A step back to the (digital) drawing board is out of the question for them. With respect to either attracting or retaining employees, an employer who obstructs innovation is not competitive in the long term. Switching to the 3D working method is a significant step towards the BIM working method. Working with component information makes it possible to expand the portfolio of services offered, and the cloud-based model exchange with design partners allows for valuable relationships to be built. This allows smaller engineering firms to keep up with the larger companies.

ABOUT THE COMPANY

ALLPLAN is a global provider of open solutions for Building Information Modeling (BIM). ALLPLAN has been advancing digitization in the construction industry for more than 50 years. Focusing on user requirements, we offer innovative tools for designing, building, and operating structures, and inspire our customers to create their visions. ALLPLAN solutions are used by more than 240,000 architects, engineers, building contractors, and facility managers in 20 languages.

With its headquarters in Munich, ALLPLAN is part of the Nemetschek Group. Over 400 employees around the world passionately continue the company's success story.

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