



Solibri Model Checker v7

THE LEADING ORGANIZATION LEVEL BIM QUALITY ASSURANCE AND ANALYSIS TOOL

The modern and open Building Information Modeling (BIM) process and information rich BIM files offer totally new possibilities to effectively and efficiently manage the design process from the early design stages through the end of construction. As buildings become more complex, architecture more ambitious and BIM widely adopted, we need new tools for managing the design and ensuring the quality of both models and the information available to us. Capabilities available to us in Solibri Model Checker, such as Spatial Coordination, Roles and Shared Resources will enhance design and construction productivity helping at the same time organizations in the AEC field in implementing and enforcing best practices on the enterprise level.

The traditional design and construction process brings additional unpredicted costs, is inefficient, affects the schedules and in many cases delivers suboptimal solutions. This has been verified by several studies including Rethinking Construction, The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction, and the NIST report showing \$15.8 billion USD annual waste in the US alone.

Spatial Coordination: Collision Detection is Only the Starting Point

Instead of waiting for complete BIM models to be handed over for pre-construction planning and checking, quality assurance tasks need to be conducted as relevant information becomes available. Model checking can be conducted throughout the project, but ideally it should be done before a design is handed over to other engineering disciplines. When design problems are fixed on site

This area does not contain any space. Consequently space calculations and BIM information might be incorrect leading in unreliable space program verification, incorrect quantities, or even exceeding the allowed area once the building is completed.

the cost is typically high. Continuous quality control, when properly established, will enable this.

Solibri has adopted a more comprehensive approach, Spatial Coordination, where collision detection is just one of the components. We are focused on how to identify real quality issues based upon compliance with existing BIM requirements and/or codes; then how to effectively manage those findings, well in advance of any meetings and design handover deadlines.

Spatial coordination requires analyzing the design disciplines that affect space usage in buildings. This includes all design disciplines. The methodology Solibri Model Checker uses is one of Rules and Rulesets. Many software applications use rules, but they are internal algorithms, often hard coded, and unable to be customized. Solibri Model Checker provides a myriad of rule templates, where the only missing information is the customers' parameters to be applied. It is also possible, with some assistance, to create entirely new rules allowing a customer to have their own 'custom flavor' of Solibri Model Checker supporting their business needs, or the needs of their clients.

Ruleset Examples

Solibri Model Checker also performs the analysis automatically, fast and reliably, dramatically lowering the cost of quality assurance. Severity classification is done automatically for all design issues located. Examples of tens of Rulesets available in Solibri Model Checker are "Space Validation", "Structural versus Architectural Model", and "Intersections

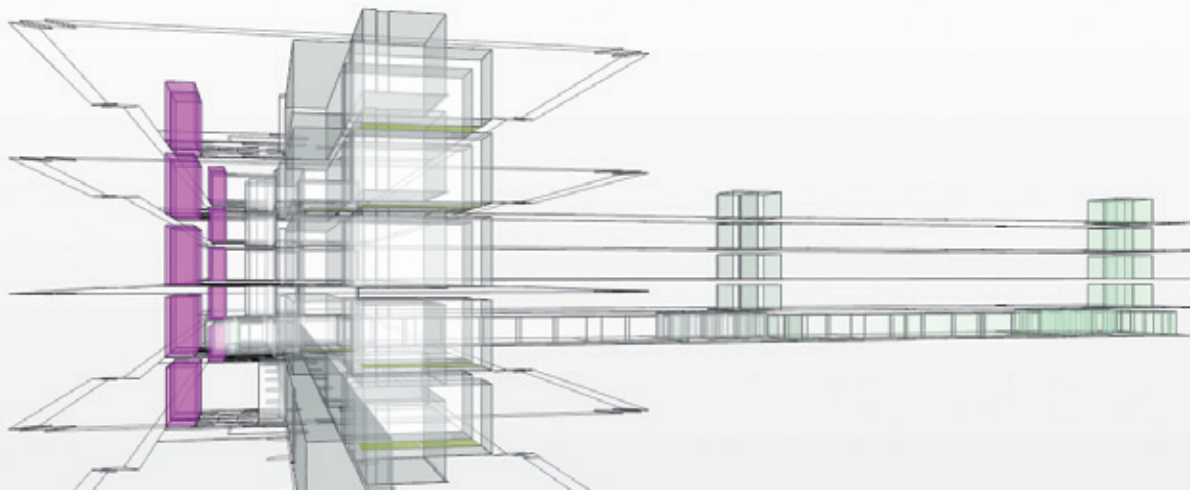
Between Domains" Rulesets. Space Validation enables us to verify that the architectural design has spaces defined according to surrounding walls. Structural versus Architectural Model Ruleset is able to verify that architectural and structural designs have load bearing walls, columns, beams, slabs, etc. located in same locations, and that openings like doors are similar in size and location.

Implementing and Enforcing Best Practices and Standardized BIM Processes: Roles and Solibri Resources

Solibri Model Checker v7 comes with preset roles such as Training, Architect, Building Code Checking, Energy Analysis, BIM Coordinator, Quantity-Takeoff, and Owner. These provide task or function specific tools for BIM experts for carrying out day-to-day work effectively.

Through Roles and by providing tools for managing shared Solibri Resources, such as Solibri Rulesets and Rule parameters, Solibri Model Checker v7 now supports straightforward organization-wide implementation of BIM QA/QC methods and best practices. Design professionals can now follow their company's QA/QC practices. The company is able to enforce "The Company Way" ensuring consistent quality. The management and distribution of Solibri resources is centralized. This allows for a shared centralized repository of Rulesets and other Solibri resources for effectively sharing, updating and managing company level QA/QC implementations, reducing IT costs. ○

For more information visit <http://www.solibri.com>



SOLIBRI MODEL CHECKER SPECIAL FEATURE

Information Takeoff: Mining the Model

For the first time, ITO makes the information in BIM available for wide use and analysis. ITO will allow “*data mining*” from the BIM by making it possible to instantly capture practically any information available and then generate customized reports.

We all have seen how 3D geometric information is visualized and Quantity takeoffs are generated from BIM files. We asked ourselves “*why should we be limited to just the quantity of geometric components, when there is so much more information available?*” We came up with an answer: Information takeoff. Whatever information you are interested in, you can collect, filter, visualize, and report – instantly! Solibri’s main focus is quality assurance and control. To be more precise, Solibri wants to make sure the required information is available, can be trusted, and follows set criteria and guidelines (e.g. building code or internal BIM guidelines). To achieve this, Solibri Model Checker uses rules to analyze information in, and various aspects of, the model. Additionally, Solibri has discovered innovative ways to verify that information. Typically, BIM information is fragmented on the component level into many thousand elements. “*You can’t see the forest for the trees*” - is a saying that applies here. Some things are easier to see than others. For example, we visualize geometrical information and by looking at it we can discover some potential problems. Through this process we have elevated detailed geometrical information to a more understandable and usable level, for all. A similar result is achieved when we generate quantity takeoffs from the BIM file, as the “*total numbers*” give us more understanding about the building or structure.

ITO

Combining the three ideas of being able to automatically check models for quality, visualize complex model information and the rich information content of BIM files, Solibri has developed an innovative capability called Information Takeoff (ITO). In brief, ITO allows users to collect information from the BIM file, organize it, visualize it, and report it - instantly. This information can include spatial areas for area calculations, envelope of the building for energy calculations, volumes, quantity takeoff and much more. Solibri has always been focused on the “*I*” (information) in BIM. Solibri Model Checker now brings the capability, and power, to ‘mine the model’ for extensive types of information to your desktop.

This will fundamentally change the way models are used. Once the data is in the model, the user will be able to capture it in whatever structure best suits the project requirements. The ability to collect, filter and instantly access all the information at your fingertips will significantly increase the value of BIM for many stakeholders.

How to Use ITO?

ITO Description is the starting point. First, you select the discipline(s) you want to work with, as there may be several models from different disciplines loaded in the Solibri Model Checker. Then you define what components you want to get information from and what properties are of interest. You can also define what rule sets should be checked to generate accurate results. Next, you define how this information should be organized (e.g. by floor, space or system).

ITO Templates

ITO descriptions can be saved for sharing with other members of the project

team or for further use with other projects. These are saved as ITO templates which can be effectively used to ensure consistency when extracting information from the model. If, for example you have created an ITO description for creating a bill of quantities of all doors and windows in your current project, the same ITO template can be used on other projects. Thus, ITO automates data extraction from models. ITO templates can also be shared between users.

ITO Reports and Report Templates

All the information that has been collected can be exported to spreadsheets for further reporting and analysis. These are called ITO Reports, and can be easily customized by the user.

ITO Samples

A number of sample ITO templates and reports are delivered with the Solibri Model Checker. Included are:

- Building Components by Blocks
- Building Element Quantities
- Component Status
- Detailed Building Component Quantities
- Flow Terminals and Valves
- Pipes and Ducts
- Spaces
- Walls by Height
- ITO and Carbon Footprint Calculations
- Building Project Hollow Core Slab Structure Cost Estimate
- Space Based Target Price Calculation

There are numerous ways to utilize BIM information by combining the information produced by Solibri Model Checker with information from other sources such as cost engineering information. ○

Visit <http://www.solibri.com> and download *Introduction to Information Takeoff*.



ENGINEERING PERSPECTIVE BIM Is Here – Are You Ready?

Rambøll is one of the biggest engineering offices in the Nordic countries. One of the most interesting and recent BIM projects is the Kuokkala Church, located in Jyväskylä in Central Finland. The architectural design was awarded in an invitation competition in 2005 to Lassila Hirvilammi Architects. Rambøll received first prize for the Kuokkala Church project in a 3D modeling competition in Finland. *“Without BIM, the church would have been impossible to design, not to mention build”* says a Director at Rambøll.

BIM Quality Assurance

In early 2010, Rambøll Finland launched a study on BIM quality assurance resulting in a Bachelor's Thesis including hands-on practical use of Solibri Model Checker and other BIM tools on Rambøll projects. The thesis concluded that because of the increasing number of AEC firms undertaking the transition from the traditional 2D design process towards BIM, and using BIM software to create building information models, the quality of design and modeling varies. During the transition, when new methods are emerging, quality assurance is extremely important.

From the business point of view the thesis concluded that higher quality delivers economic and environmental benefits, but it also contributes to customer satisfaction. The consulting firms, who master BIM today, ensure their future market share in the future.

One of the main goals of the thesis was to study quality assurance using modeling software used by Rambøll, access their usability for quality assurance, and compare them with Solibri Model Checker. It was concluded for example that Navisworks focuses more on combining models and geometrical information than BIM information or quality assur-

ance. *“When analyzing IFC models, Solibri Model Checker was found to be in its own class. Also, Solibri Model Checker was found to be very valuable even if modeling tools themselves had inbuilt quality assurance functionality”* says Bachelor of Engineering, Max Levander, who wrote the thesis. Max Levander is also the Solibri main user at Rambøll Finland.

BIM Quality Assurance Process and 10,000 Stones

The largest prefab concrete project ever for Rambøll Finland is The Myllypuro Shopping Center project, with almost 10,000 concrete elements, or stones as the engineers call them, and cast in situ concrete structures. Most of the elements have been modeled. With 10,000 prefab elements come almost 10,000 drawings. *“Solibri Model Checker has been used for internal engineering design quality control in the Myllypuro project, and has proved to be very valuable”* Rambøll states. In addition to BIM modeling Rambøll Finland offers also BIM coordination services.

Rambøll Finland's Building's Division has in place quality assurance system which fulfills ISO9001:2008 requirements, but it has been audited and certified by the National RSA (Rakli-SKOL-ATL) quality system council. *“Currently the ISO based quality assurance system is being amended by creating guidelines for BIM quality assurance and defining the use of Solibri Model Checker as a part of the open-BIM process”* says Max Levander.

Rambøll Head Office Project in Denmark
Rambøll Denmark has explored the use of 3D tools such as AutoCAD, Tekla Structures and MagiCAD in construction design and projects for years. Rambøll Denmark has concluded that IFC is the best tool for the job allowing for an optimal work process. Use of IFC allows for flexibility also. IFC model based check-

Rambøll Head Office, Dissing+Weitling architecture. Visualization courtesy of Rambøll Denmark.

ing with Solibri Model Checker was introduced at Rambøll starting in 2008. Today it is the standard procedure on almost all major 3D projects.

The new Rambøll Head Office - a 40,000 m² building will be located in Orestad South, an area of Copenhagen currently under development. The client of the Rambøll Headquarters project is SEB Rambøll being the main user occupying most of the building. Rambøll has been responsible for construction design with Dissing+Weitling architecture being responsible for the architectural design.

The working method has been based on using IFC for information exchange. Dissing+Weitling have made the architectural model with AutoCAD Architecture, and exchanged model information with Rambøll, who has used Tekla and MagiCAD for structural engineering and MEP design. Clash detection and checking for consistency has been carried out with Solibri Model Checker.

Modern tools and placing the project team in the same room for improved communication and collaboration has resulted in increasing design quality, easy communications, improved project management, good IFC quality and a highly motivated team. ◊

Rambøll

Rambøll is a leading engineering, design and consultancy company founded in Denmark in 1945. Today Rambøll employs close to 9,000 experts with a strong presence in Northern Europe, Russia, India and the Middle East. With almost 200 offices in 20 countries Rambøll emphasizes local experience combined with a global knowledge-base. For more information on Rambøll visit <http://www.ramboll.com>.



BUILDING OWNER PERSPECTIVE BIM Has Payback

The Public Works Department (PWD) - Construction Management (CM) manages the construction of Helsinki's public buildings and public spaces on the basis of orders placed by the City's administrative bodies and other clients. Their measure for success is that the client needs are satisfied, projects are delivered within the schedule on budget, and the environmental impact of projects is within the limits that have been set.

PWD-CM has over 100 people working for them and the annual spending in design and construction services of around 100 million euros. PWD-CM has been firmly involved with BIM since 2005. Their first BIM project was the Senior Citizens Care Center of Kontula, a 50 million euro hospital project which was carried as an OpenBIM project where all disciplines produced their designs in IFC format. A consecutive project was the Haartman Hospital, a 40 million euro hospital. Similarly, all design disciplines produced IFC models. Plans were reviewed in coordination meetings using Solibri Model Checker.

Aulis Toivonen, PWD-CM's principal Project Director, has gained expertise on many OpenBIM projects. Haartman Hospital project was his first complete OpenBIM project. His most recent project is the Lapinlahti Hospital. The hospital was originally designed by Carl Ludvig Engel, a German architect known for his neo-classical style, and completed in 1841.

Also this project also was conducted as an OpenBIM project. Based on the experience collected from the earlier projects the target was flawless design:

- High emphasis for designers to perform quality assurance themselves
- Full design coordination and removing discrepancies during design phase

- Support for cost estimating, models to be used for QTO
- Model utilization during construction > schedule optimization, support for construction scheduling
- Minimizing change orders

The design was carried out in accordance with Senate Properties BIM Requirements 2007. The requirements describe instructions for all design disciplines and how each designer must perform quality assurance before model delivery. Solibri Model Checker includes Senate's BIM requirements in the form of rules that can check automatically compliance with Senate's requirements.

Request for Proposal

In the Lapinlahti Hospital project knowledge from past BIM projects was utilized during the RFP process. The emphasis was on the quality of the design. All planning was required to be done using BIM. When tenders were received the results were confusing: for example, the best quality points were awarded to a chief architect who had the lowest price. In fact, a number of high quality scoring offers were found amongst those with the lowest prices.

Architect Jouni Kulmala with Lasse Kosunen Oy explains the reasons as follows: *"The use of our tools has significantly improved as we have adopted the OpenBIM approach."* The architect's firm has actively used ArchiCAD software since 1991, and Solibri Model Checker QA/QC solution has been in use since 2008

Aulis Toivonen interprets the results: *"It seems to me that designers who have integrated BIM in their workflow are able to do better quality in less time. Apparently some designer can utilize inventory models better as they don't need to remodel this part. Now that the design phase has been completed,*

Visualization of the Lapinlahti Hospital by Tietoa Finland Oy

and we have not seen any (typical) change orders we need to assume that the work estimates were quite accurate."

Quality Assurance

Tietoa Finland Oy was assigned to the project as quality assurance consultants. *"We have used Solibri Model Checker for this purpose since 2008 and furthermore Solibri's trained our staff to perform commercial BIM quality assurance with a dedicated training program."* says Marko Rajala from Tietoa Finland Oy. The practical quality assurance is a continuous process that collects BIM files from designers before each design meeting and then in the meeting the progress is introduced with the models. The status of design is shown with the models and analysis reports. This enables a clear and transparent view of how complete the design is at this phase. This also serves very well for decision support if changes are needed for the design. This very straightforward procedure improves constructability and helps to avoid typical change orders and scheduling problems on the site. *"In short continuous quality assurance is a practice that really works"* says Marko Rajala.

Conclusions

Aulis Toivonen states: *"OpenBIM enables high quality and (close to) flawless design outcome, and with efficient tools cost savings during both design and construction phases."* The OpenBIM projects that Public Works Department -Construction Management has completed have taught a lot, and each project has achieved significant improvements. By doing things right the first time it is possible to do better quality with lower price and effort. ○



ARCHITECTURAL DESIGN PERSPECTIVE

Challenges Create Capabilities

Larkas & Laine Architects Ltd is one of the largest architectural offices in Finland. In addition to being one of the biggest architectural practices in Finland, Larkas & Laine is a leading BIM office. The company has invested heavily in modeling on demanding design projects, and places great emphasis on modeling capabilities and internal quality control. Business process development has not been driven by external requirements but has been a result of pursuing perfection in architectural design.

Demanding Projects Create Capabilities

One of the current design projects Larkas & Laine is working on is the future headquarters of Skanska Finland. The project is architecturally demanding because the headquarters will be located at the beginning on Mannerheimintie where buildings create an entry point from the north to Helsinki. In addition, Skanska has demanding requirements for both design and BIM quality. In Skanska's experience, modeling increases the quality of design, making it easier to reach a 0 design error target. Skanska has concluded that BIM represents a competitive advantage for their business.

"From the architects point of view high quality requirements for both architecture and BIM is an advantage" says Mr. Harri Salminen who is both an architect and a partner in the company. *"High quality requirements for architecture and BIM create challenges but enable us to continuously improve our skills and stay on the leading edge"* continues Harri Salminen.

BIM in the Architect's Practice

The Larkas & Laine view is that building information modeling is the only solution

for high quality and error free design.

Larkas & Laine decided in 2003 that all new projects would be modeled. At the same time, the competencies of the staff are being systematically developed. For example, in 2009 the company used over 700 training days for sharpening modeling skills. Larkas & Laine have developed company specific project and modeling methodologies. One significant aspect is interoperability, the possibility to share design information in the form of models, made possible by BIM and adopting the IFC standard. Interoperability has one direct consequence - model quality and quality control are of the utmost importance.

Quality Control in BIM Projects

For BIM quality assurance Larkas & Laine uses Solibri Model Checker. The basic principle in quality assurance is that all models leaving the office go through the model checking process. In case the design is released as an ArchiCAD model, the model is transferred directly to Solibri using the ArchiCAD Link for the Solibri Model Checker, an ArchiCAD add-on produced by Solibri. The quality assurance is then carried out within Solibri Model Checker. Model checking is automated by Solibri Model Checker and studying the design issues pinpointed in the architectural model is very efficient. Components and issues found by Solibri Model Checker are directly selected in ArchiCAD for redesign. Today it is customary that models are released in IFC format in BIM projects. Larkas & Laine exports the model into IFC format and check the IFC quality using Solibri Model Checker in order to guarantee that the quality meets the quality standards.

Quality assurance has been integrated seamlessly in the modeling process.

Skanska Finland Head Quarters, Helsinki, Finland. Larkas & Laine Architects.

The target for quality control at Larkas & Laine is that all models go through the quality control process whether they are released outside the office or not.

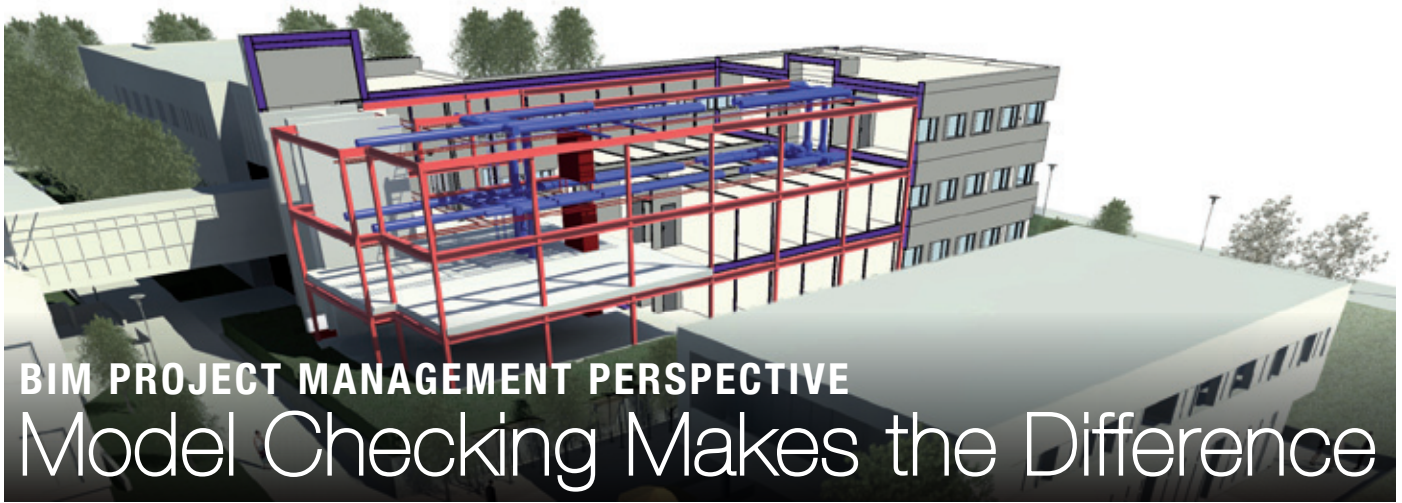
Easy and Efficient Workflow

Modeling with ArchiCAD and quality control with Solibri Model Checker saves time and makes the design process more productive. *"Transferring the architectural model to Solibri Model Checker, using Solibri for fast, reliable and automated quality control and analysis, and the direct selection of design issues in ArchiCAD makes the work flow extremely efficient and easy"* says Harri Salminen. Solibri Model Checker makes it possible to find design issues which would be impossible to find otherwise and produce continuously consistent and high quality models.

Leading edge BIM competencies and high quality also affect customer satisfaction and retention. *"Quality is equally important in every project because all of our customers are repeat customers. Ensuring high quality internally enables us to build confidence between our office and our customers"* architect Harri Salminen says. Long customer relationships are also important to Larkas & Laine because they lower the number of projects acquired through bidding.

Larkas & Laine Architects Ltd

Larkas & Laine is one of the leading Finnish architectural practices targeting high level architecture and high quality built environment. Larkas & Laine was established in 1993 and employs more than 60 people today. For more information on Larkas & Laine visit <http://www.larkaslaine.com>.



BIM PROJECT MANAGEMENT PERSPECTIVE

Model Checking Makes the Difference

BIM is a combination of technology, methods and processes. Succeeding on a complex BIM project with multiple stakeholders, multiple engineering disciplines and multiple CAD tools requires a common platform for successful digital collaboration. At Multiconsult this is accomplished using buildingSMART standards and a building information model checker, Solibri Model Checker, combined with interdisciplinary control meetings, an approach which has produced great success on the Stavanger University (UiS) project – Statsbygg's first official BIM project.

BIM Requires a Coordination Platform

"In order to be able to coordinate multiple design disciplines we need a common denominator. For us it is the openBIM standard IFC which we require that all tools support. When it comes to BIM tools for the administrative project staff, we have chosen to use Solibri" says BIM manager Thor Ørjan Holt of Multiconsult, a leading engineering company in Norway.

Why Solibri Model Checker?

Solibri Model Checker is a program which is able to automatically analyze the quality of BIM models and the designs. "This analysis and coordination is absolutely invaluable. This is because different models are not usually coordinated. Some design issues, or errors, will always remain, and often they are interdisciplinary. In order to ensure the highest quality and cost effectiveness it is necessary that we can find these errors

and correct them as early as possible in the project. If errors or deficiencies appeared at the site the cost could be very high" says Holt.

Preparatory Control Is Important

"Especially important in keeping the control meetings effective is that project management prepares the meetings in advance with Solibri" says Holt. "One of the purposes of this practice is that we do not primarily use the interdisciplinary control meetings for revealing problems. Instead we discuss both who should be responsible for correcting errors, and the timing of the corrections so that the schedule will be kept. This way project staff gets to use most of their time on what they are best at, namely the project" says Holt.

Structured Control

"This has to do with visibility" says Holt. "The combined models alone are too complex. By integrating and matching the models by different design disciplines, and also controlling each individual model the project leader is able to make an overall assessment of the progress and quality of each model and whether the designs have been coordinated" Holt continues.

Prioritize

"It is important to make decisions and prioritize. All design issues are not equally important. It does not make any sense to require corrections if they are not important. Thus you need to spend a minute considering what is important and what is not. From experience we know that visual control will

catch about 60% of errors, which is twice what we used to catch using drawings from 2D systems. But Solibri does not stop here" continues Thor Ørjan Holt.

Rule Based Model Analysis with Solibri

"I can also use Solibri for making more detailed analysis of the building information model using Solibri's predefined rule sets for interference detection and finding collisions in places where they should not exist. Or you can do the opposite and have Solibri Model Check that components join properly. And out comes a list of design issues to be resolved, sorted by components. This is something only Solibri Model Checker can do" says Holt.

True Results

"We are succeeding on the UiS project much better than any other project we have done thanks to Solibri and the BOS-working method we use", says Holt. "When everyone is gathered in the same room communication is easy and direct so that we can quickly solve problems. You sit down for a short moment and find a solution to the problem" Holt continues. "Solibri combined with professional knowledge provides great value in BIM context. However, when combined with multidisciplinary expertise you really get great benefits from the tool" emphasizes Thor Ørjan Holt. ○

MULTICONSULT

MULTICONSULT is one of Norway's leading consulting engineering companies with more than 20 offices in Norway and abroad. The head office is located in Oslo. For more information on MULTICONSULT visit <http://www.multiconsult.no>.



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