Unlocking Building Information Modelling for MEP Designers

Dramatic time and cost savings achieved through powerful 3D physical models incorporated into building design

A WHITEPAPER BY PROGMAN
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1. DESIGNING FOR THE FUTURE: INTEGRATING ALL BUILDING PROCESSES

Collaboration and work have almost always been synonymous. People need other people to realise their greatest impact. The last 20 years have brought a convergence of communications and computing technologies that has expanded the possibilities for technology-enabled collaboration, whether synchronous or asynchronous, proximal or distant.

With all of today’s technical tools being connected via the Internet—everything from mobiles to tablets to high-performance computers—information is easily accessible, from anywhere. This has enabled communication and collaboration in all areas of life and business. Stakeholders can collaborate on projects of every type like never before.

BUILDING AND CONSTRUCTION ARE NO DIFFERENT.

The latest evolution of the building industry, Building Information Modelling (BIM), refers to the process of designing a building collaboratively using a single coherent system of 3D models rather than separate design drawings. BIM incorporates people and technology to streamline time and cost, and improve efficiency in builds including skyscrapers, hospitals, and large office or residential buildings.

Picture: BIM Workflow

*Source: MIT Technology Review. Technology Will Make Collaboration Your Next Competitive Advantage by Jeffrey F. Rayport on March 1, 2011*
**MEP design** as part of an overall BIM workflow (as depicted above) isn’t just software, nor is it simply a 3D model. It contains not only the model elements but the vast amounts of information that make up the project, as well as the process of exchanging that information with other parties involved. Whereas previous workflows relied on multiple file formats and disconnected processes that quickly became out of sync when changes were made, BIM workflows allow for a much more dynamic and synchronised approach to project management.

BIM not only helps to design a building during the planning phase, but during construction, costing and management of the building as well – through the five total levels depicted in the graphic below.

![Building Information Modelling Types](image)

3D – A model that includes 3D shape information

4D – Time allocation & construction sequence scheduling added to 3D model

5D – Cost & simulation of construction

6D – Energy analysis & simulation of building performance, materials and LEED (Leadership in Energy and Environmental Design) tracking

7D – Data added which allows for the operations/ maintenance & facilities management

But is complete BIM possible for MEP designers? **At present no single solution exists** that can enable project stakeholders to communicate at levels 3D through 7D. However, Progman is one of the few companies that has made significant headway in its world-class BIM solution for mechanical, electrical and plumbing (MEP) design aspects – MagiCAD – a powerful MEP design software that uses 3D physical models. It can also incorporate elements of 4D (creation of a components list prior to construction and installation) 5D (through tender calculations, logistics, production control) and 6D (enabling transfer of energy simulation assets from other third-party applications).

This whitepaper defines how Progman MagiCAD (within AutoCAD or Revit) and MagiCloud (the online product catalogue) are making the design process faster, less costly, and easier for MEP designers around the world. MagiCAD has built a worldwide reputation for being user-friendly and intuitive. MEP designers all over the world have credited MagiCAD with bringing the fastest functionality possible to their designs.

*Source: Zion Research. Global BIM Market 2015-2019*
2.

DOES BIM REALLY MATTER?

Globally, the BIM market was valued at USD 1.75 billion in 2014 and is estimated to reach USD 5.82 billion by 2019, growing at a CAGR of 17.43%. In a 2014 Smart Market Report from McGraw Hill Construction, contractors were surveyed on BIM across 10 international countries.

The key findings showed:
1. Three quarters of all contractors reported a positive return on their investment in BIM
2. Over the next two years, the same contractors expect the percentage of their work that involves BIM will increase by 50 per cent on average

The contractors cited the following benefits of BIM:

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**CONTRACTORS CITING BIM BENEFIT AS AMONG TOP THREE FOR THEIR COMPANY**

*Source: McGraw Hill Construction, 2013*

- Reduced Errors and Omissions: 41%
- Collaborating with Owners/Design Firms: 35%
- Enhancing Your Organization’s Image: 32%
- Reducing Rework: 31%
- Reduced Construction Cost: 23%
- Better Cost Control/Predictability: 21%
- Reducing Overall Project Duration: 19%
- Marketing New Business: 19%

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*Source: Zion Research. Global BIM Market 2015-2019*

*Source: 2014 Smart Market Report from McGraw Hill Construction*
As the red line in the graph (above) demonstrates, by dynamically connecting design, analysis, and documentation in a BIM workflow, most of the effort in a design project is shifted back into the detailed design phase, when the ability to impact project performance is high and the cost of making design changes is low. This allows engineers to spend more time evaluating what-if scenarios to optimise the design, and less time generating construction documentation. With this in mind, consider how adopting a BIM process translates into real benefits for MEP design. The impact of any MEP services can then be valued, including plant room provisions, risers, access and void openings. All the elements of the MEP design can be determined more accurately and cost simulations are more realistic.
3.

MAGICAD - MATCHING PRODUCTIVITY IDEALS WITH TODAY’S POSSIBILITIES

Progman brings MEP designers the ideals of BIM today. At heart, Progman’s software solutions enable the evolution of the design process from simple computer-aided drafting, to BIM. The solution saves designers time, money and effort in communicating in one environment.

MagiCAD is one of the most popular MEP design and calculation BIM solutions available. It offers a high level of automation with powerful drawing and calculation functions on top of AutoCAD or Revit MEP. MagiCAD makes producing accurate and calculated designs (along with data-rich BIM product models and user-configurable printouts) easier, more flexible and less time-consuming. It includes easy-to-use yet versatile tools for MEP design including: heating and cooling; ventilation and air conditioning; water, sewer and sprinkler systems; electrical, lighting, data and telecommunication systems; electrical circuits of differing complexities; and, energy-efficiency optimisation calculations.

Designs can be made comprehensive not just with physical specifications but layered with such details as lighting conditions, heating conditions, air flow – essentially, what it will feel like for people inhabiting the building. Noise levels, sizing, balancing, and pressure can all be built into a design and analysed.
4.

INSIGHT MATTERS EVEN MORE FOR MEP DESIGN - BIM PRODUCT DATABASES

The example below demonstrates that MEP usually has many more components than all other building components in the building project combined. Hence, having access to data-rich and up-to-date product libraries, and being able to create accurate designs by automating design tasks, can drastically increase productivity.

4.1 INTELLIGENT PRODUCT MODELS AND DATABASES

MagiCAD product databases empower MEP designers one step further by enabling them to include real product models into their plans from the database of more than one million current products from 200 manufacturers. The database can be accessed in MagiCAD natively or via the cloud service, MagiCloud.

All product models in MagiCAD are accurately modelled based on their physical appearance and dimensions, including precise collar lengths and all other needed data. This way, designers can ensure as early as the design phase that the product will physically fit the space for which it is designated. The dimensions and the comprehensive technical data contained by the models are always checked and

*Source: Tero Järvinen, Granlund*
verified by the manufacturer before the models are published. The technical data enables accurate calculations and the ability to verify that the design actually meets the requirements. The system's networks can be balanced on site.

Without the MagiCAD database, a designer would be creating their own models by themselves. In addition to volumes of extra work, keeping up to date with ever changing product specifications requires close communication with manufacturers. Because of these factors, designers end up with product specifications based on hypothesis rather than reality, and then may have trouble sourcing the correctly-sized components, or after the build will find that the system doesn't work as planned and cannot be balanced.

With MagiCAD the true list of components enables designers to visualise a real system with real products before the build begins. The systems can be analysed to ensure they are working properly before the fabrication and construction begins.
4.2 MAGICLOUD

MagiCloud enables online browsing of MagiCAD’s full product model catalogue making it available and accessible to all parties involved in the building design process. In MagiCloud, over one million MEP products are visualised as data-rich 3D models, with accurate dimensions and comprehensive technical data for full BIM implementation.
5. COLLABORATION BETWEEN ALL PARTIES INVOLVED IN BUILDING PROJECT

MagiCAD enables more efficient project collaboration, interoperability and data transfer between various software and systems. The IFC import/export function enables connectivity with all IFC compliant software. Using MagiCAD’s Property Set Manager, it is possible to define the information content exported with the selected objects.

In addition, by exporting and importing user-configurable technical data in a spreadsheet format, it enables the selection of data and parameter values from MagiCAD’s intelligent product objects. The data can be exported to e.g. Excel, where values can be searched and replaced, and formulas and calculations can be applied. The data can then be imported with changes back into MagiCAD.

PROVISION OF VOIDS

1. MEP designer makes Provision for Voids objects in MagiCAD.
2. Objects are delivered to structural designer in IFC format.
3. Structural designer approves or rejects demands. Report is generated.
4. Structural designer creates holes where demand was approved.
5. Structural model is delivered back to MEP designer.

An in-built function in MagiCAD, the Provision for Voids tool enables an MEP designer to communicate all of the cut-outs in the architectural elements to allow for HVAC, drainage, power, lighting and data facilities. As explained in the customer example (above), the data can then be exported into structural design software.
6. MAKING MISTAKES IN DESIGN PHASE, NOT ON SITE

In the design flow, after an architect builds plans for the shell of the building, MEP designers are responsible for building in what can constitute miles of ductwork and piping, shafts, switches, HVAC units and wiring. Inevitably, areas of collision or interference will occur – where a pipe is needed but an architectural element stands in the way.

For example, perhaps there isn’t enough space built in between a ceiling and a slab for necessary ductwork. Integral collision detection in MagiCAD makes this process of checking and rechecking considerably faster. Snapshots can be taken from the 3D model to save the coordinates of the components that are colliding. The plans then need to be shared with other stakeholders to agree a suitable compromise involving cut-outs in the architectural model.

Using the BIM Collaboration Format, sharing information becomes easier and cheaper for not only the MEP design team, but all working electrical, plumbing and heating designers.

Customer Example 1: Insulation takes part of the height and therefore it would have been impossible to install. A decision was made to lower the position of the pipes during the design phase.

Customer Example 2: What is wrong in the original plan? Nothing technically, but once the maintenance person saw it, he realised that he would need a ladder to reach the valves. A design decision was made to lower the valves.
7.

A BUILDER’S SHOPPING LIST

At the end of the design process, using the database of true components, designers can create a list of needed products -- the “Bill of Material” list. This is like a shopping list that can be taken directly to manufacturers to source goods before the build begins. MagiCAD has a powerful BOM tool that enables the user to drill down into the model to the smallest detail. The BOM function is used throughout a project for purposes such as tender calculations, logistics, production control, scheduling and cost and time simulations. In this way, the MEP designer is making use of the advanced level 5D of BIM, the cost and simulation of construction. This unrivalled view for MEP designers into their future costing is unachievable without MagiCAD.
8. CONCLUSION

Full scale, end-to-end BIM is a reality that the industry is moving towards. Tools like MagiCAD can deliver all the benefits of BIM for multiple phases of the build. With MagiCAD being fully supported and in continual development, end-to-end BIM is a concept for now, not for the future. The picture (below) summarises how a MEP designer can use BIM technology and save time, money and effort in communicating in one environment with other parties. Further, read how MEP designers at Skanska are using MagiCAD today to make BIM a reality, in the below case study.

*For example: IFC export, property set manager, BCFZip tool, spread sheet link for import export of information/parameters.  Copyright 2016 Progman Oy

** Same libraries are inside MagiCAD for the users and can be included straight into the project.
The project consists of approximately 330,000 square meters. The hospital will include approximately 8,000 rooms, 36 operation rooms and 630 in-patient beds in private, single-patient rooms. Construction began on the site in 2010 and the final construction phase is scheduled to finish by 2018. As part of a PPP agreement, once the construction stage is completed, the project company will continue to manage the project also during the maintenance and facility management stage, which will continue until the year 2040. Reflecting the sheer size of the project, the total contract sum for the construction in the NKS project, discarding hospital equipment, is 14.5 billion SEK.

Skanska is responsible also for the project’s building services systems design and installations. All building services design in the project has been carried out using MagiCAD for AutoCAD with the modules MagiCAD Heating & Piping, Ventilation, Electrical, Room, and Sprinkler Designer.

With hospitals, there is always a great deal of technology involved, and fitting various different technologies together tends to be a challenge. “MagiCAD enabled modelling of all building services, including special systems for medical gases”, comments MEP Manager Mikko Lehto from Skanska, one of the coordinators of MEP design and installations in the project.

“One of the most important benefits of MagiCAD in the project is the amount of information that is transferred and stored within the models, especially when the project model will continue to be used later in the facility management and maintenance stage. You could say that true building information modelling capability is already a very significant benefit in itself.”

The New Karolinska Solna (NKS) is a model project in the utilisation of building information modelling (BIM) methods on the construction site. Practical BIM utilisation on the site by the main contractor Skansa and MEP supervisors makes processes more efficient and improves information flow during design, construction and MEP installations tremendously.

“On site, project coordination has been carried out using a composite Navisworks model. When supervisors, managers and engineers have access to the model and drawings via iPads, and the builders and installers are able to use all the important information where and when it is needed, the quality of work is improved and significant amounts of time can be saved as the workers and supervisors do not have to regularly waste their time moving across the enormous construction site just to check something,” explains Mikko Lehto.

Especially in projects of this magnitude, modelling is the key to examining and verifying plans visually together with architectural and structural models. It also makes project coordination and communication more efficient.

The building information models enable us to examine installations that have already been completed, and to verify whether the installations have been made according to design. For example, if a plumber improvises, problems usually surface immediately when the next subcontractor arrives at the scene to install their contribution to the system. This is why, as a rule, all installations in the project were expected to be carried out the same way they had been designed and how they were represented in the BIM model.
After the construction stage, the models will be updated with the actual as-built information, and the information model objects and their technical data content can be connected directly with product-specific information to better facilitate the maintenance and facility management routines in the later stages.

The lifecycle aspect of the project also placed additional emphasis on certain aspects of modelling, such as ease of maintenance, which affected the positioning of valves, regulators, cleaning hatches and similar components and equipment to make sure they are accessible. In main risers, for example, the placement of dampers was examined and adjusted to make sure they can be maintained in a safe manner. At the same time, it was ensured that there would be enough space to perform all the necessary maintenance procedures after the building and all the installations are completed.
Progman is a Finnish software company with over 30 years of experience in developing solutions for the building services industry, specialising in products and services for the design of heating, piping, ventilation, sprinkler and electrical systems.

Our MEP BIM software MagiCAD for Revit and AutoCAD is the most popularly used building services design software in Northern Europe and Russia, and is rapidly growing in Europe and China. Progman is part of the international Glodon Group, the leading construction software company in China.

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