



**A WHITE PAPER PREPARED BY
FIRST Q NETWORK**
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FIRST Q
NETWORK

BUILDING INFORMATION MODELLING FOR MEP SYSTEMS
Where we are and where we are going



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INTRODUCTION

According to a recent study by the Mc Kinsey Company, construction is the biggest industry in the world (it represents 13 percent of global GDP) and yet it is not performing well: construction has seen a meagre productivity growth of 1 percent annually for the past two decades, and that is only a third of total economy averages. Time and cost overruns are the norm, and overall profits before interest and taxes (EBIT) are only around 5 percent despite the presence of significant risk in the industry. Digitalization is lower than in nearly any other industry.

The lagging performance of the construction industry is a direct result of the fundamental rules and characteristics of the construction market and the industry dynamics that occur in response to them. Cyclical demand leads to low capital investment, and bespoke requirements limit standardization. Construction projects are complex, and increasingly so, and logistics need to deal with heavy weight and many different parts. The share of manual labour is high, and the industry has a significant shortage of skilled workers in several markets. Low barriers to entry in segments with lower project complexity and a significant share of informal labour allow small and unproductive companies to compete. The construction industry is extensively regulated, subject to everything from permits and approvals to safety and work-site controls, and lowest-price rules in tenders make competition based on quality, reliability, or alternative design offerings more complicated.

In the coming years, fundamental change is likely to be catalysed by changes in market characteristics, such as scarcity of skilled labour, persistent cost pressure from infrastructure and affordable housing, stricter regulations on work-site sustainability and safety, and evolving sophistication and needs of customers and owners. Emerging disruptions, including industrialization and new materials, the digitalization of products and processes, and new entrants, will shape future dynamics in the industry.

Two of the most relevant disruption changes required are:

Industrialization: Modularization, off-site production automation, and on-site assembly automation will enable industrialization and an off-site, product-based approach. The next step in the transition to efficient off-site manufacturing involves integrating automated production systems— essentially making construction more like automotive manufacturing.



Digitalization of products and processes. Digital technologies can enable better collaboration, greater control of the value chain, and a shift toward more data-driven decision making. These innovations will change the way companies approach operations, design, and construction as well as engage with partners. Smart buildings and infrastructure that integrate the Internet of Things (IoT) will increase data availability and enable more efficient operations as well as new business models, such as performance-based and collaborative contracting. Companies can improve efficiency and integrate the design phase with the rest of the value chain by using building-information modelling (BIM) to create a full three-dimensional model (a “digital twin”)—and add further layers like schedule and cost—early in the project rather than finishing design while construction is already underway. Automated parametric design and object libraries will transform engineering. Using digital tools can significantly improve on-site collaboration. And digital channels are spreading to construction, with the potential to transform interactions for buying and selling goods across the value chain.

For this objective of increasing productivity by industrialization and digitalization, Building Information Modelling (BIM) is seen as one of the essential tools to be applied in the building industry.

BIM claims several benefits when applied in the design, construction, and operation of buildings. A recent market report by Dodge Analytics shares research done among engineering companies in the USA, Germany, France and United Kingdom to identify the most relevant advantages of using BIM in their projects. From more relevant to less relevant:

- Less design mistakes.
- Better cost estimation.
- Better project definition.
- Reduction of construction time
- Better design.

Independent research conducted by several professional bodies, such as ORI (Organization of Consultancy and Engineering Firms,

the Belgian chapter of EFCA), shows that the cost of a full BIM model averages between 1% and 1.5% of the investment value of the designed project. The research also indicates that the additional costs associated with the generation of a BIM model is equivalent to 15% of the fee for a conventional project.

BIM as a design tool has moved quickly in the recent years from industrial projects to commercial ones. In this respect there are some specific issues that make BIM design for MEP (Mechanical, Electrical and Plumbing) systems a bit more sophisticated, making the BIM progress for MEP systems slower than for the rest of building components. Two of these specific requirements are the need to integrate a lot of different products and systems in the model, and the need to use the model for load and systems and networks calculations.

First Q is a European network of MEP consulting engineering practices, comprised by 15 engineering companies from all over Europe, with more than 4.000 staff. One of the most important objectives of the network is to generate and disseminate technical knowledge and information at European level. First Q has published already two white papers on relevant topics: Smart Buildings (2019) and Nearly Zero energy buildings (2021).

The intention of this third white paper is then to provide up to date information on the real status of development of BIM as a design and construction management tool for MEP Systems, to suggest future lines of development and to show inspiring best practices to the European AEC (architectural, Engineering, Construction) community.

We hope these ideas will push the productivity and efficiency of our industry further.

THE SURVEY

To understand the existing development, benefits, and constraints of the use of BIM for the design and construction management of MEP systems, we have conducted a pan-European survey among our partners.

We include here the consolidated results of 12 top level European MEP consulting engineering offices, out of the 15 members of First Q.

1. The introduction of BIM in MEP projects

The percentage of BIM projects (in comparison with 2D design) has grown very fast in the last 5 years, from 60% of projects designed in BIM to 85% today. Nearly all MEP projects will be designed in 3D very soon. Fig.1

2. The penetration of BIM per building types

Today, the penetration of BIM in projects is quite homogeneous with respect to type of client (public or private) or type of project, being lowest for residential projects (72%) and highest for healthcare and industrial projects (85%). So, it seems that BIM works better for high complexity buildings: Fig.2

3. When does BIM appear into the design process and up to which level?

One of the relevant decisions to be taken in the project is when to move from early sketches to the proper 3D models. Moving into BIM too early in the process can make design very rigid, but moving too late implies a risk that sketched solutions do not really work when put in real size and location.

We cannot see a clear trend on this issue across Europe: First Q companies start using BIM at concept design stage in 50% of their projects, and they incorporate BIM at detailed design stage for the other 50% of their works.

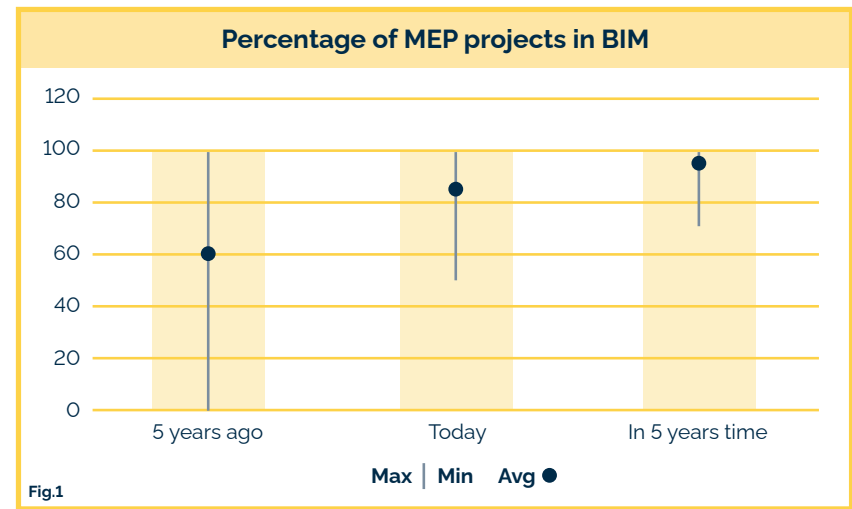


Fig.1

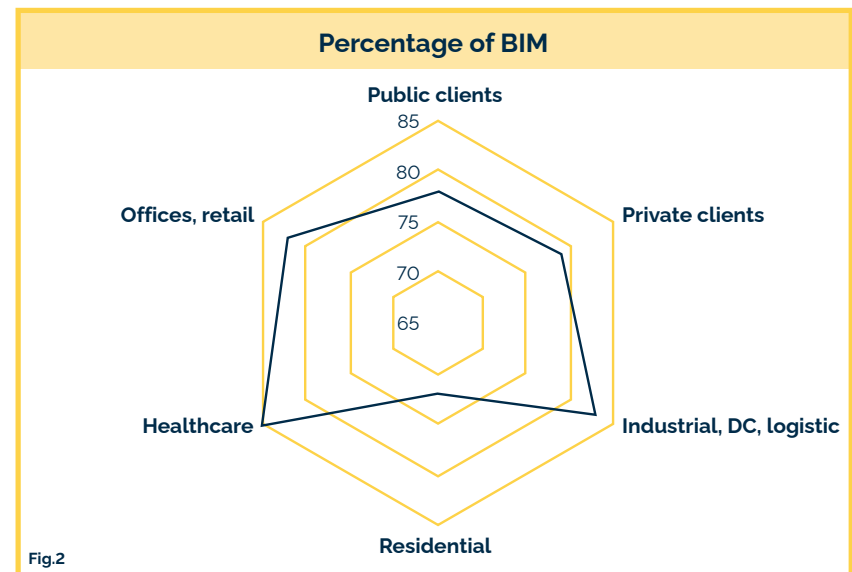


Fig.2

There are also some discussions among clients and project teams about what Level of Development (LOD) should BIM models be delivered at different project stages. Here, First Q companies mostly agree that LOD 200 would be the standard for concept design stage and LOD 300-400 would be the standard for detailed design stage.

As different countries and regions may have their own BIM standards and guidelines outlining what each LOD level should entail, we can say that most of the time, LOD 200 represents the model including approximate geometry, size, shape, location, and orientation of the building elements.

At LOD 300, the BIM model becomes more detailed, incorporating accurate geometry, specific quantities, size, shape, location, and orientation of building elements. The model represents elements as specific assemblies, and it is typically used for detailed design and documentation. Moving to LOD 400, the model includes detailed and specific information necessary for fabrication, assembly, and construction.

4. What are the BIM tools used by MEP consulting engineering companies?

There is a nearly unanimous choice for Autocad REVIT as the BIM design tool among MEP engineering companies across Europe. Only one of 12 companies reported using other software (Magicad) as their main design tool.

Most of the First Q members complement Revit with other software tools to increase their productivity. Among the most common are: Linear, Solar Computer, Cadmatic, Trimble, Solibri, Assemble, Granlund Designer.

5. BIM human and technical resources

Although most of the First Q companies develop most of their BIM job in-company, there is some degree of outsourcing in a few of them: Fig.3

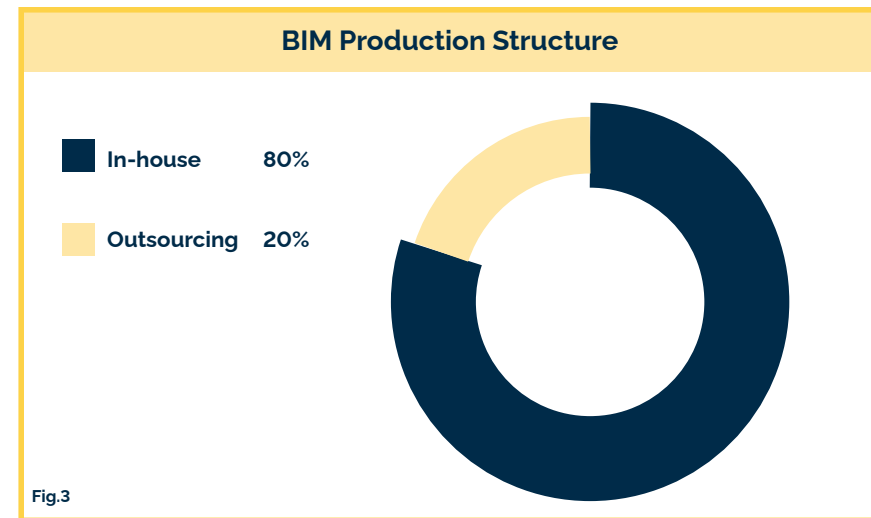


Fig.3

The outsourced BIM capabilities come both from local partners and international companies. Half of the First Q companies are hiring BIM production services from Indian design offices.

First Q members agree that outsourcing is a good tool for adding flexible capacity into their companies, but successful outsourcing is not easy: it takes more time to prepare, explain and checking of the work received.

BIM software licenses are still quite expensive, so the right decision on the number of them is a strategic one. Too many will mean an economic burden, but too few will limit the company production capacity.

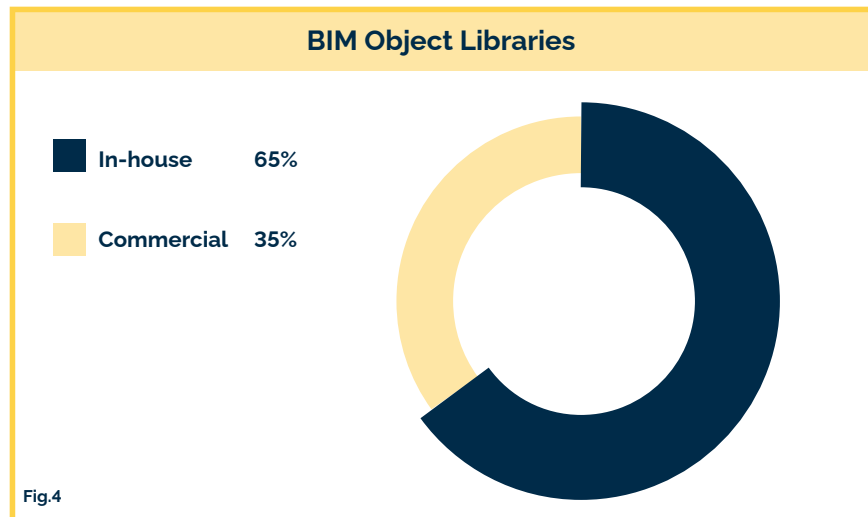
When asking First Q companies about number of licenses, we find a wide span of answers, going from 100% (one license per employee) in one of the newest companies to 15% in one of the biggest. The average number of BIM (mostly Revit) licences is 1 per every 2 employees: 50%

6. Bim design tools and object libraries

When using BIM as a design tool, a key decision is where to obtain the different building "objects" from, and how to improve the design process efficiency by incorporating simple or more sophisticated design support tools.

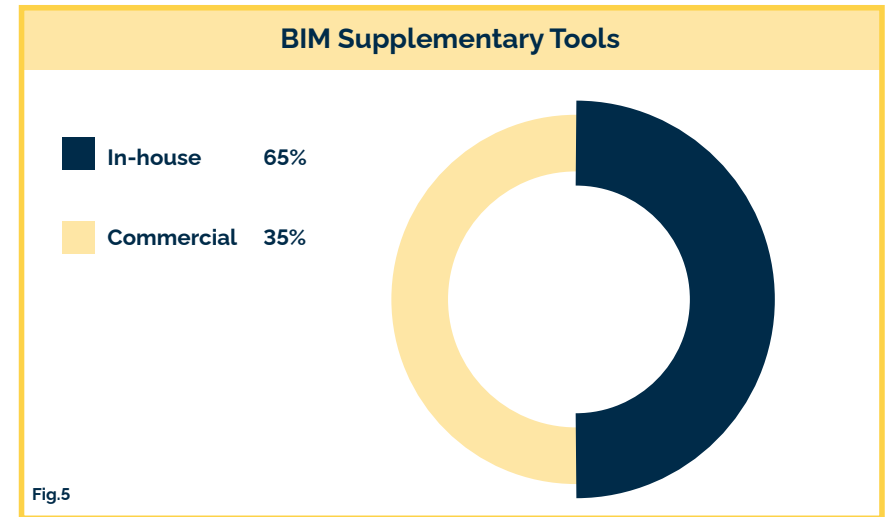
BIM objects libraries can be developed in-house or incorporated from others (equipment suppliers, public source objects, professional bodies). In-house developed libraries are more expensive to develop but will probably match better with every company way of working.

The general trend in Europe is that most (65%) of BIM objects for MEP projects are developed in-house, although there is a large variation span from 0 to 95% on this issue. Fig.4



As one of the companies says: "Commercial / Manufacturer sourced BIM components often overly complicated, don't align with company standards and can behave unpredictably within the BIM software. A good in-house BIM library of components which can be adapted to suit specific project requirements, and include non-graphical data are always favourable and much more efficient".

Another relevant decision is to develop the supplementary design tools in each company or use available commercial ones. As with the question of the BIM object libraries, the options on this topic are quite open among European engineering companies, going from 0 to 85% in-house development, with an average of 50%: Fig.5

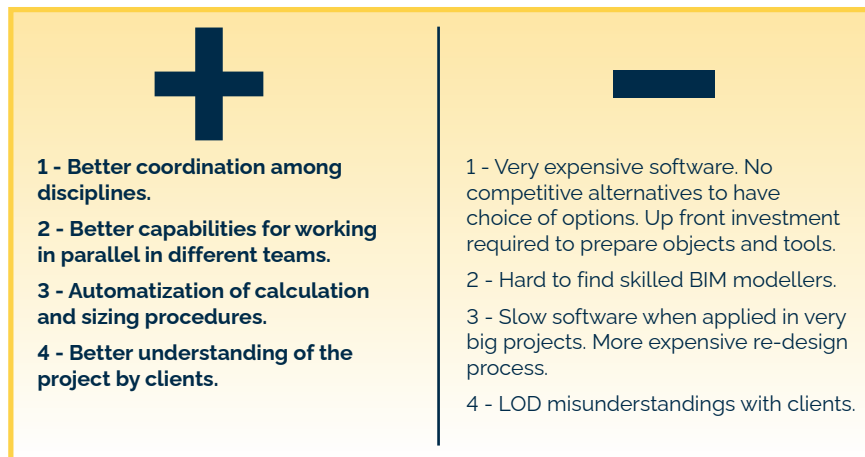


Commercial BIM tools used by First Q companies are: Magicad, Linear, Caneco, Ideate, Stabicad, Solibri, Dirroots One, Solar Computer, Cadmatic

In house BIM tools are more focused on proper engineering design: electrical cabling sizing, duct and pipe sizing, heat losses calculations, etcetera.

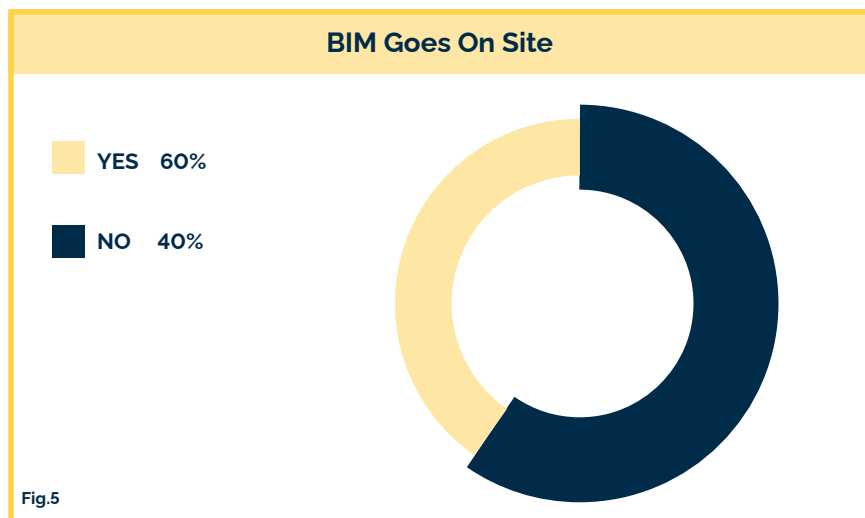
7. BIM pros and cons in the design phase

When asked about benefits and limitations of BIM in the design phase, First Q companies specify several issues:



8. BIM goes on-site.

The power of BIM in the construction industry is maximized when used also in the construction and operational phase of the building. First Q companies report that more than half of the BIM projects are managed on-site with the BIM model:



9. BIM 4D to 7D – Scheduling to operation

The last set of questions refer to the use of "dimensions" 4 to 7 of BIM: scheduling, quantity and cost, energy and sustainability and facility management and operation.

Again, here the intention is to know the real use of BIM for these aspects of the building construction and operation.

There is no real use of BIM as a programming or scheduling tool (4D) among MEP engineering companies, probably because this role in the construction site is normally played by other agents (architects, project managers). Only one out of 12 companies report using BIM-based tools for project programming, using Bentley Synchro and SimpleBIM.

Because BIM is an object-oriented design tool, it is in principle quite easy to produce bills of quantities directly from BIM models (5D). In our First Q companies, half of them produce quantities reports and cost estimates using normally in-house developed templates and tools.

BIM 6D refers to the possibility of using the model for energy/sustainability calculations for the building. Being this normally part of the standard MEP design services, it is logical that up to 70% of companies use the BIM model as a source for other energy simulation programs: Design Builder, IES, Riuska and Solar Computer.

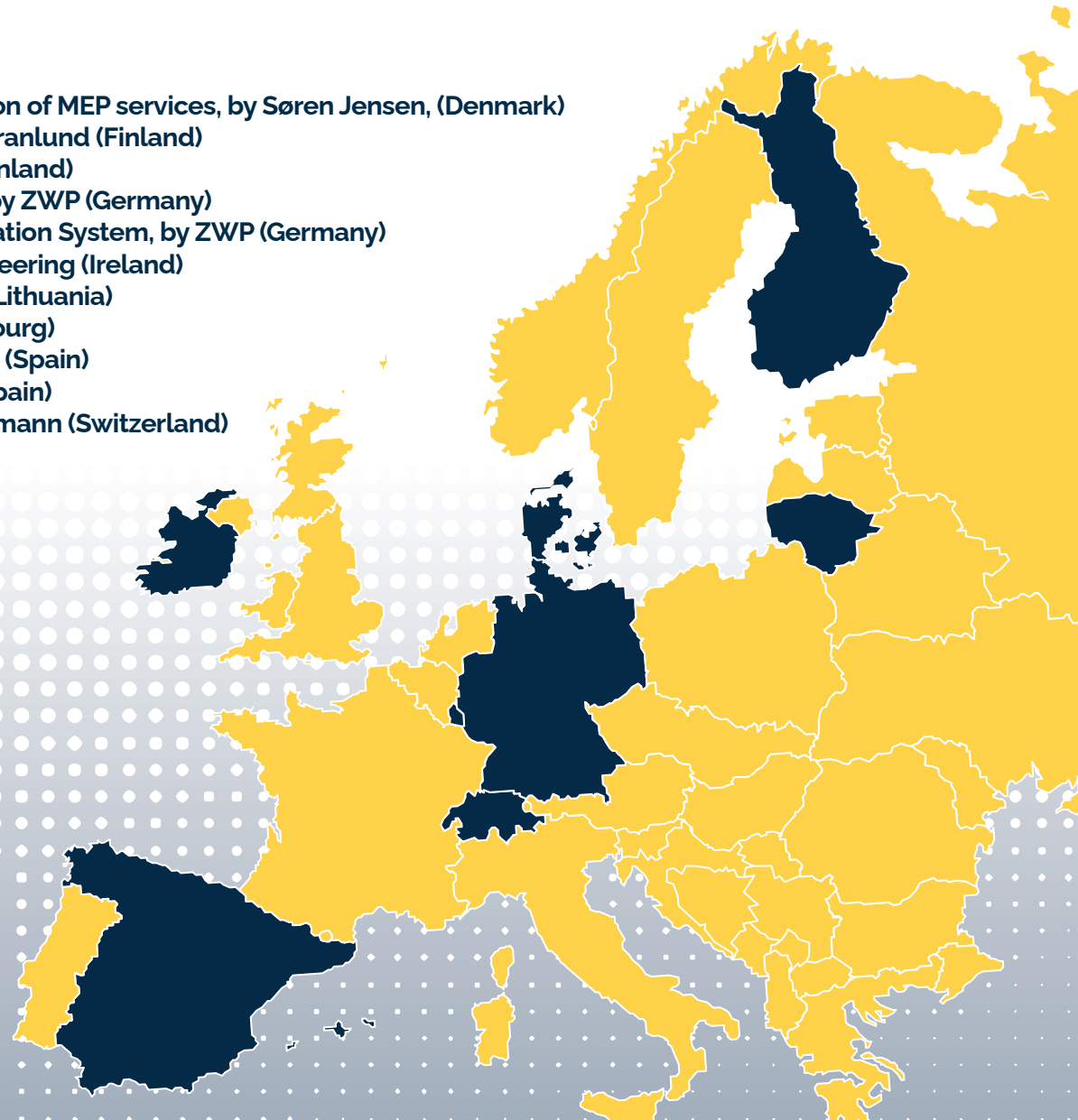
Finally, nearly half (45%) of First Q members are providing Facility Management consultancy services (7D), and those members take profit of the BIM model using it as a source for their FM tools: objects and information are extracted directly from the model and for visualisation using IFC visualizer.

BEST PRACTICE EXAMPLES

We include in this section a selection of best practice applications of BIM for building services projects, with the intention that they serve as inspiration to our readers.

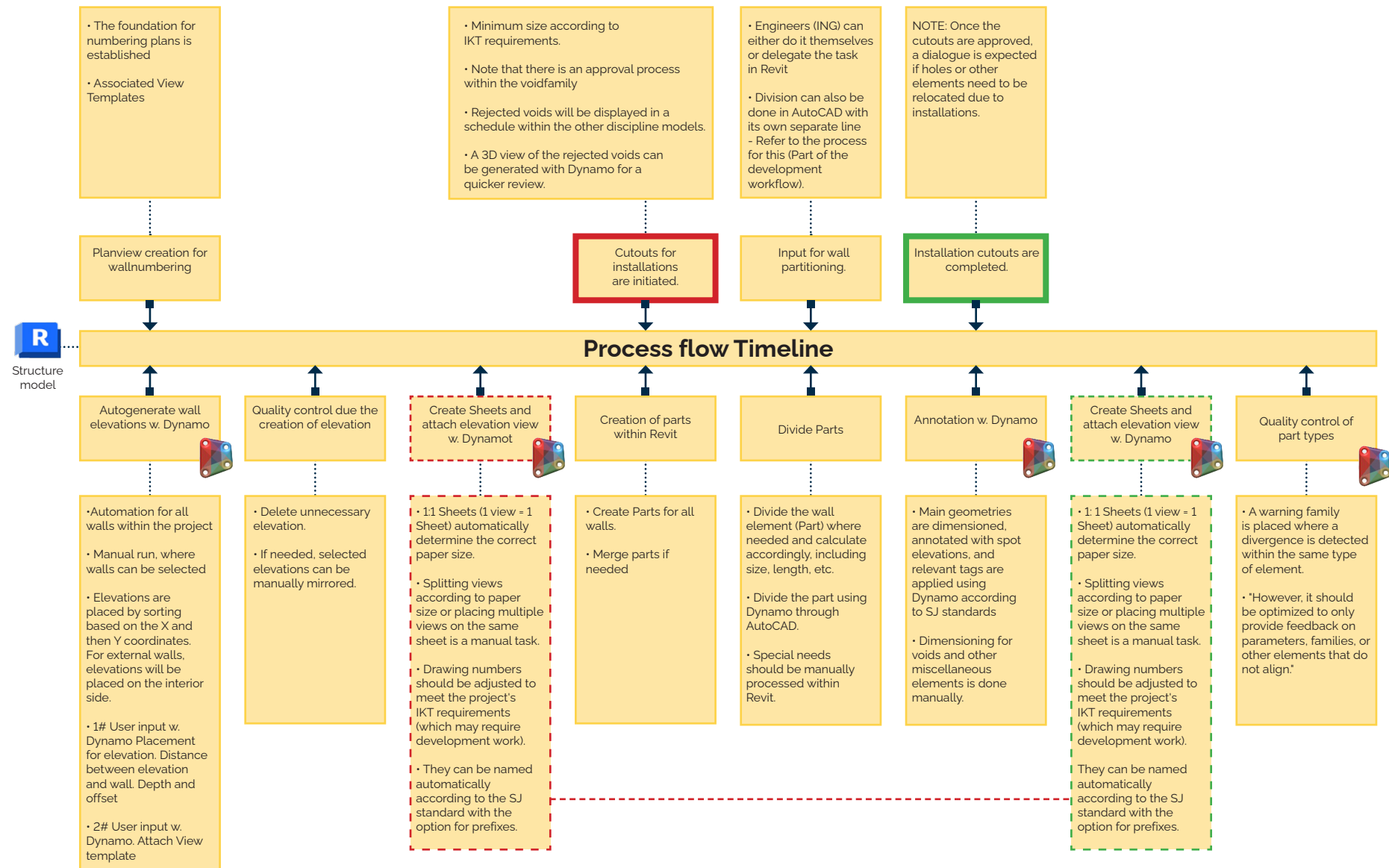
The examples we show here are:

- A standard workflow for the design of walls and integration of MEP services, by Søren Jensen, (Denmark)
- A process for the provision of voids for MEP systems, by Granlund (Finland)
- BIM 4D: Using BIM for project scheduling, by Granlund (Finland)
- A project developed with Autodesk Construction Cloud, by ZWP (Germany)
- Automated process for the creation of the Asset Identification System, by ZWP (Germany)
- Reality capture for remote site inspection, by Ethos Engineering (Ireland)
- Project workflow for prefabrication drawings, by Mepco (Lithuania)
- Clash control in the cloud, by Goblet-Lavandier (Luxembourg)
- A smart building platform based on BIM, by JG Ingenieros (Spain)
- BIM to full power at the design stage, by JG Ingenieros (Spain)
- Advanced 3d coordination process, by Waldhauser – Hermann (Switzerland)



A STANDARD WORKFLOW FOR THE DESIGN OF WALLS AND INTEGRATION OF MEP SERVICES, BY SØREN JENSEN, (DENMARK)

When designing buildings in 3D, the different elevations of the walls have to be integrated with the MEP systems that run into them. We have developed a detailed process flow to ensure that this integration is done with the maximum quality:



A PROCESS FOR THE PROVISION OF VOIDS FOR MEP SYSTEMS, BY GRANLUND (FINLAND)

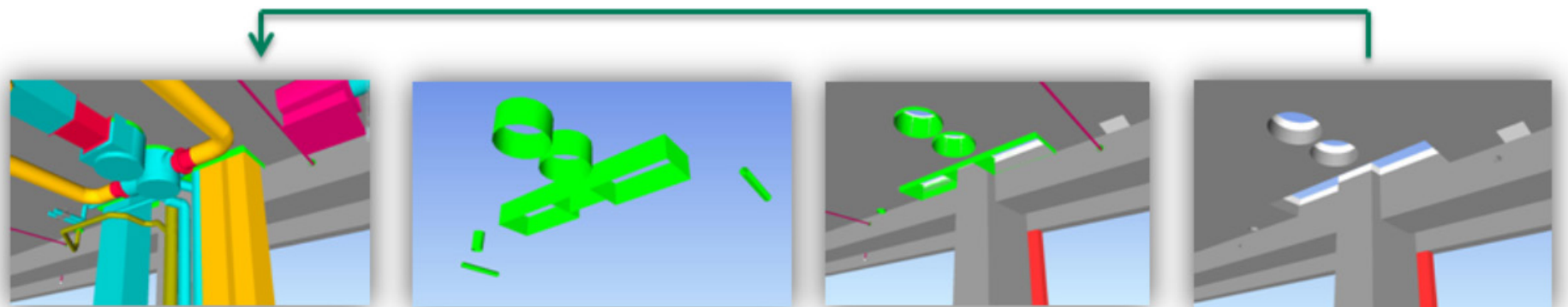
A BIM based process for creating and commenting provisions for voids has been used in Granlund for quite some years now.

The process is roughly this:

- MEP designers create the provision objects either automatically and/or manually. The automatic process still requires human checking.
- MEP designers export IFC files (usually by floor) which only contain the provision for void objects and the export is done including IFC property set "Provision for voids" (named Pset_ProvisionForVoid in IFC) that comes with MagiCAD installation.
- Structural designers can then import the voids into their Tekla Structures model and usually accept or deny the individual voids and also give comments for the individual voids (e.g. why it was denied and moving it e.g. 100mm to certain direction would make it acceptable).
- Structural designer can then export the status information and comments to an .XSR file and deliver it to MEP designers.
- MEP designers can then import the .XSR information to MagiCAD and the information is written to the original native provision for void objects.
- MEP designers can then make required adjustments (and/or create new voids according to the design phase). Thus, creating new IFC files for delivery and the process starts again from step one.

This is the description of the process when using MagiCAD for AutoCAD (for MEP) and Tekla Structures (for structural design) software. Tekla Structures is the dominant structural design software in Finland.

If MagiCAD for Revit (for MEP) and Revit (for structural design) is used the process changes a bit as MEP designers would deliver native Revit model containing the provision for void objects instead of IFC files. We show here the process in a simplified picture:

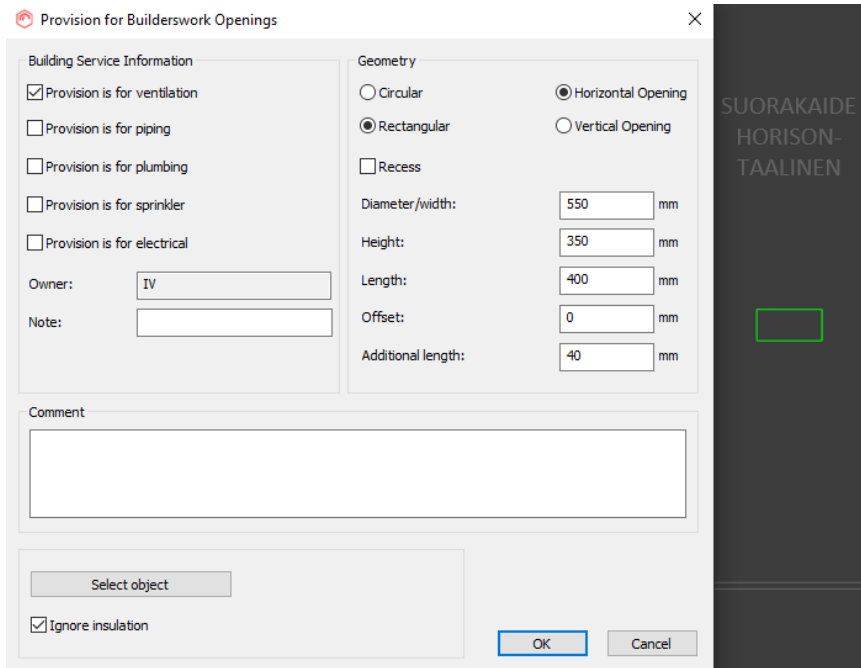


MEP designers create the provision for void objects

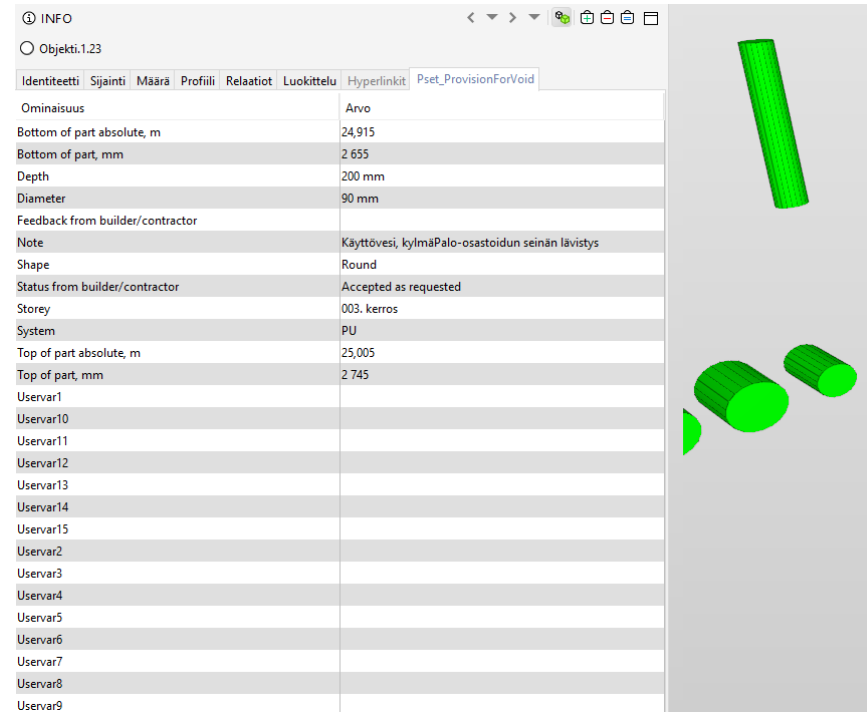
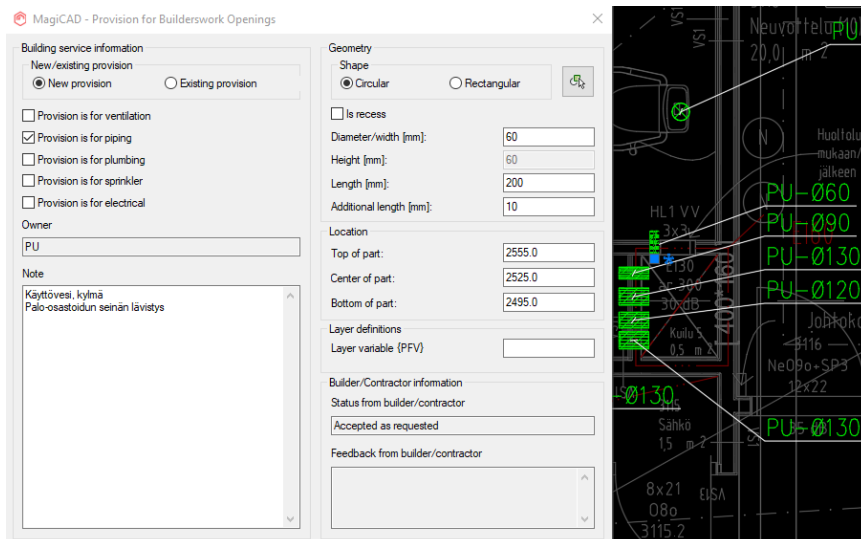
Provision for void objects is delivered to structural designer in IFC format

Structural designer uses the objects for accepting, rejecting, and commenting the voids

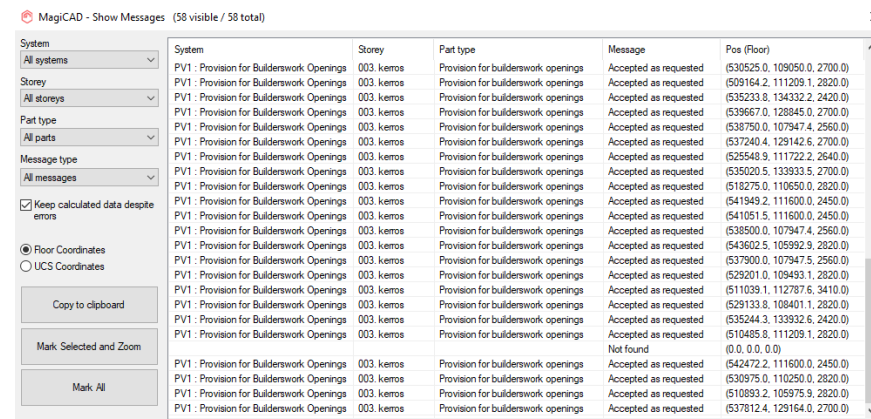
The accepted voids are created to the structural model



- A provision for void object and manual creation window in MagiCAD for Revit.



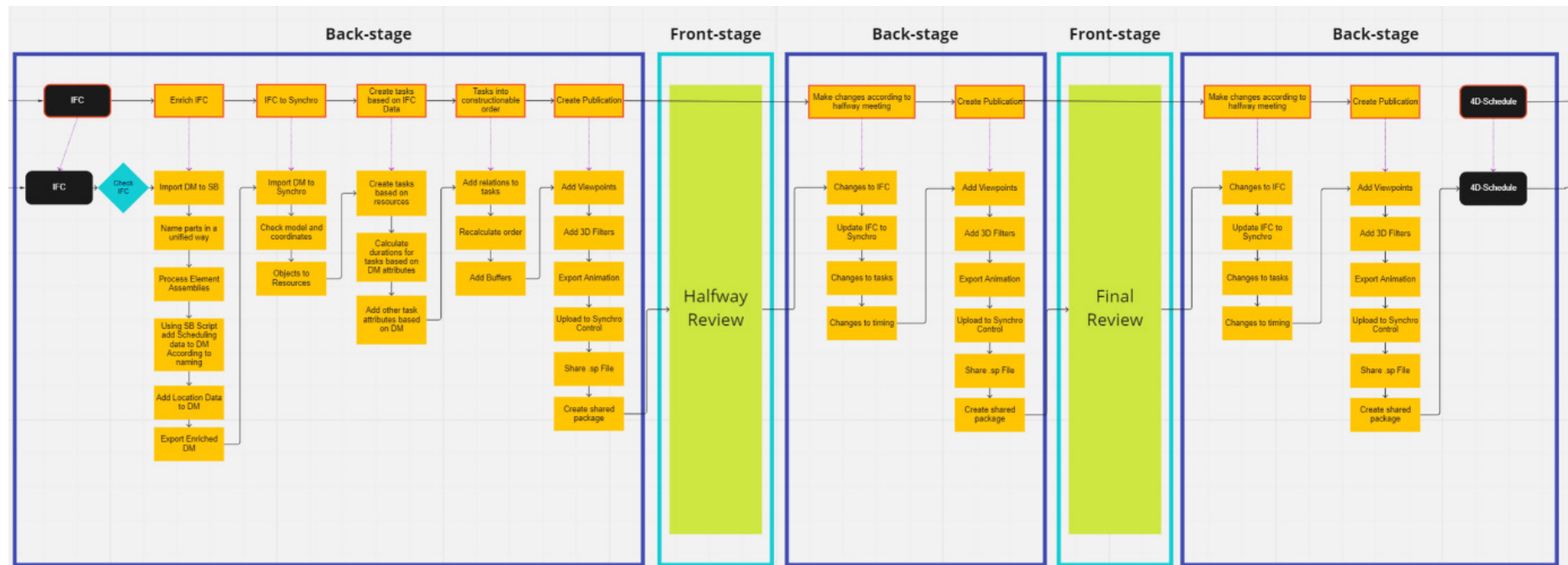
- Provision for void objects and their Pset_ProvisionForVoid IFC property set as seen in Solibri.



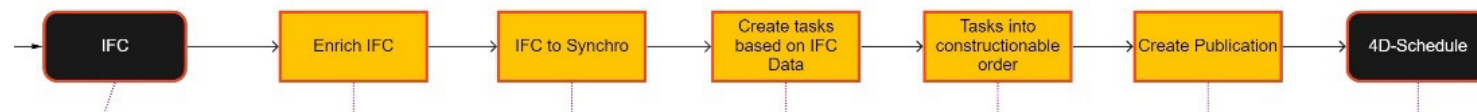
BIM 4D: USING BIM FOR PROJECT SCHEDULING, BY GRANLUND (FINLAND)

A BIM(IFC) based process for scheduling projects utilizing automation and standardization. The system is capable of scheduling projects very fast, in standardized manner and efficiently. For “normal” sized projects frame 4D schedule within 2 weeks, MEP within 4 weeks.

The following is a full view of the process:



And this is a simplified version:



The result is shown in visual and understandable schedules that enable different professionals from different fields to work together. The system works for any size of project, for example in mega projects the MEP (10's of millions of objects) work can be scheduled on object level thanks to automation.

Our BIM based process calculates duration for each object automatically based on our classification system. After location information is added, Synchro 4D can use all this data in the 4D schedule to get math-based,

The following is a snapshot from Synchro:

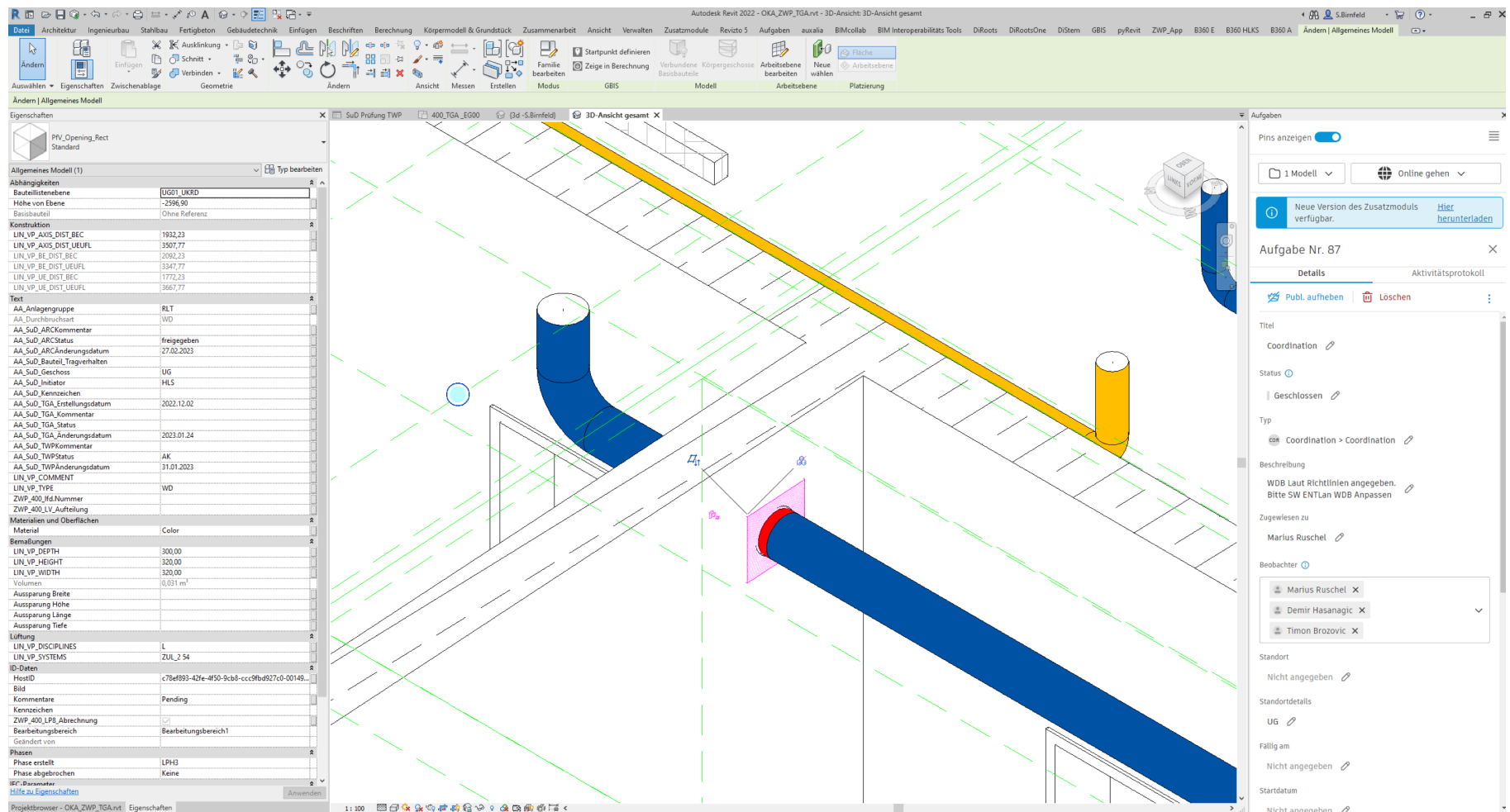
optimized schedules. Inside Synchro 4D, task length is based on the objects that are assigned to the task. Assigning is done automatically using some Excel routines and auto-matching. The schedule can then be further optimized using multiple techniques, both traditional and 4D enabled. The task creates the link between the 3D BIM and time axis, creating 4D. We aim to do as much as possible in one scheduling environment to make things clearer and more efficient. Hence, we also follow/steer the schedule/production and update things using Synchro 4D and our data enrichment processes.

The screenshot displays the Synchro 4D software interface. The top portion shows a Gantt chart with a timeline from July 2021 to January 2023. The chart contains numerous task bars, many of which are labeled as '0% Complete'. The tasks are organized into a hierarchy, with some tasks expanded to show sub-tasks. The bottom portion of the interface shows a 3D model of a construction site, with various structures and elements rendered in different colors (green, blue, yellow, purple). The interface includes a menu bar, a toolbar, and a status bar at the bottom.

Name	Durati on	Start	Finish	Progress
Katos - Lohko D - 1.kerros	1d, 2h, 2...	4:12 PM 2/21	10:36 AM 2/21	0% Complete
Katos - Lohko C - 1.kerros	1d, 2h, 2...	10:36 AM 2/21	1:00 PM 2/21	0% Complete
Katos - Lohko B - 1.kerros	4h, 48m	1:00 PM 2/21	9:48 AM 2/21	0% Complete
PVP Elementit - Lohko D - 1.kerros	7d, 1h, 3...	2:38 PM 2/11	4:12 PM 2/21	0% Complete
Tilamalliaikataulu - Lohko D	40d, 5h, ...	11:24 AM 1/11	5:00 PM 3/7	0% Complete
Tilamalliaikataulu - Lohko C	35d, 4h, ...	9:00 AM 1/21	1:48 PM 2/1	0% Complete
Tilamalliaikataulu - Lohko B	35d, 6h, ...	3:24 PM 1/21	1:48 PM 2/1	0% Complete
Suunnitelmatarve - Lohko D	0d	9:00 AM 1/21	9:00 AM 1/21	0% Complete
PV-Perustukset - Lohko C - Kellari	5d, 6h, 2...	1:00 PM 1/21	11:24 AM 1/1	0% Complete
PV-Perustukset - Lohko D - Kellari	2d, 6h, 2...	11:24 AM 1/11	9:48 AM 1/11	0% Complete
Suunnitelmatarve - Lohko C	0d	9:00 AM 1/21	9:00 AM 1/21	0% Complete
Suunnitelmatarve - Lohko B	0d	9:00 AM 1/21	9:00 AM 1/21	0% Complete
Suunnitelmatarve - Lohko A	0d	9:00 AM 1/21	9:00 AM 1/21	0% Complete
Tilamalliaikataulu - Lohko A - Kellari	29d, 2h, ...	9:00 AM 1/21	11:24 AM 1/1	0% Complete
Tilamalliaikataulu - Lohko A - 1.kerros	8d, 3h, 1...	9:00 AM 1/21	12:12 PM 2/1	0% Complete
Tilamalliaikataulu - Lohko A - 2.kerros	13d, 3h, ...	12:12 PM 2/11	3:24 PM 2/1	0% Complete
Tilamalliaikataulu - Lohko A - 3.kerros	4d, 7h, 1...	4:12 PM 2/11	3:24 PM 2/2	0% Complete
Betoniauto	27d	9:00 AM 1/21	5:00 PM 1/11	0% Complete
betonipumppu	27d	9:00 AM 1/21	5:00 PM 1/11	0% Complete
kaivinkone-1	7d	9:00 AM 1/21	5:00 PM 1/21	0% Complete
kaivinkone-4	3d, 2m	9:03 AM 1/11	9:05 AM 1/11	0% Complete
Torninosturi	100d	9:00 AM 1/21	5:00 PM 5/2	0% Complete
Ti-hyönte	5d	9:00 AM 1/21	5:00 PM 1/21	0% Complete
Seinän nostotyö	5d	9:00 AM 1/21	5:00 PM 1/21	0% Complete
Betoniauto	25d	9:00 AM 1/21	5:00 PM 1/11	0% Complete
Laatikko	10d	9:00 AM 1/21	5:00 PM 1/21	0% Complete
kaivinkone-3	6d, 3m	9:00 AM 1/21	9:03 AM 1/11	0% Complete

A PROJECT DEVELOPED WITH AUTODESK CONSTRUCTION CLOUD, BY ZWP (GERMANY)

In this project, all design is done by all project stakeholders in Autodesk Revit software. The goal is to enable seamless planning by using native files that ensure continuous data transfer. This allows relevant information and parameters to be stored, shared, and reused in the model.



We use the Autodesk Construction Cloud (ACC) internally due to the cross-location work, and then we take profit of the intensive use of the advantages of communication via cloud:

- Issue creation
- Coordination of tasks
- Clear task definition and assignment
- Traceability of processing
- No mails necessary

There are, nevertheless, some disadvantages with this approach, like the need for the manual publication of models.

The function for creating issues is used intensively, especially for slot and breakthrough planning. Internal communication takes place exclusively via the ACC. Since the coordination of the trades and the slot and breakthrough planning take place in parallel, we have established this process.

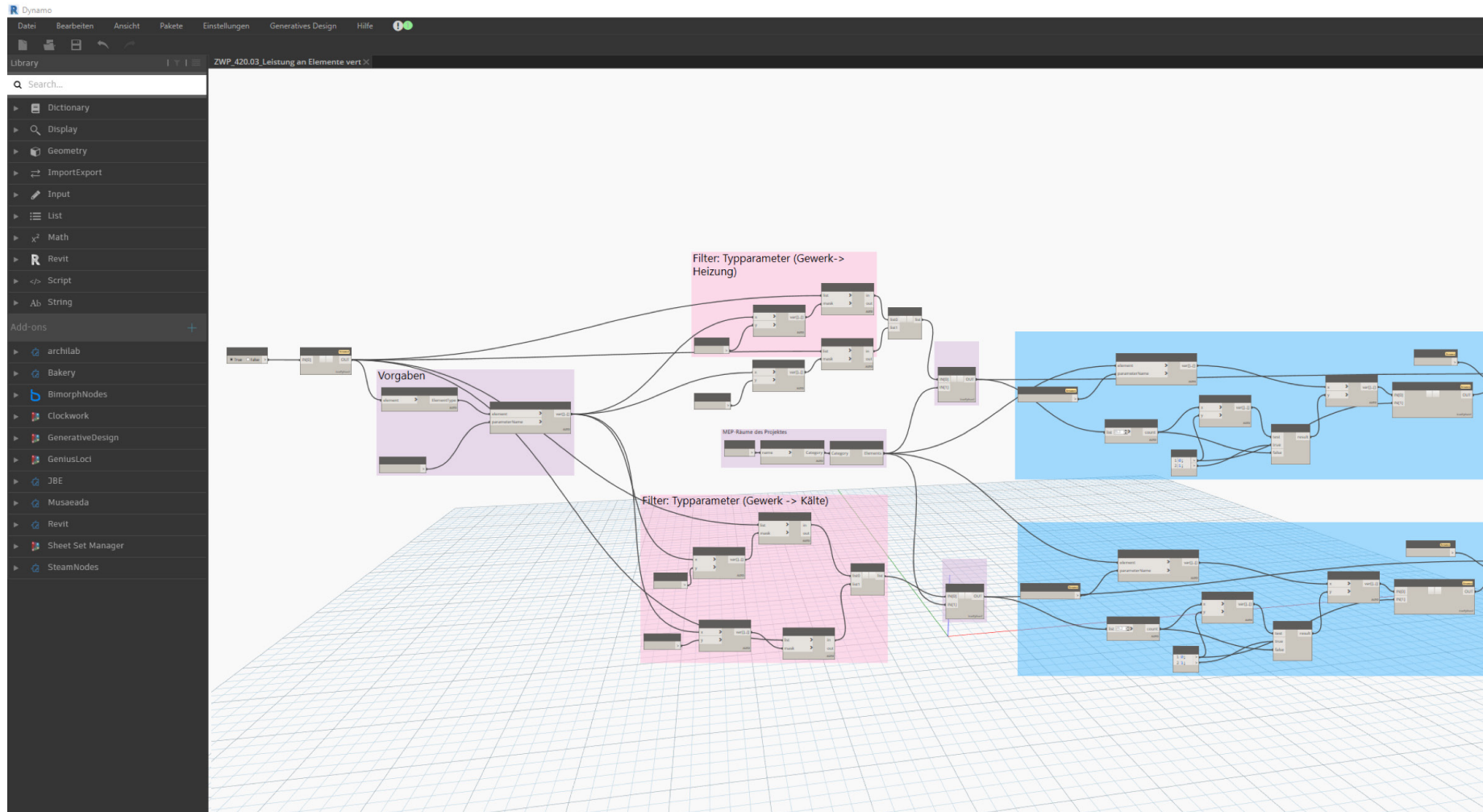
ID	Titel	Status	Typ	Zugewiesen zu	Beobachter	Fällig am	Startdatum	Platzierung	Erstellt von
#122	Coordination	Offen	COR	Monika Banaš	Monika Banaš, v han, Ti...	-	-	OKA_ZWP_TGA.rvt	v han
#121	Coordination	Offen	COR	Monika Banaš	Monika Banaš, Timon B...	-	-	OKA_ZWP_TGA.rvt	v han
#120	Coordination	Offen	COR	Monika Banaš	Monika Banaš, v han, Ti...	-	-	OKA_ZWP_TGA.rvt	v han
#119	Coordination	Offen	COR	Monika Banaš	Monika Banaš, v han, Ti...	-	-	OKA_ZWP_TGA.rvt	v han
#118	Coordination	Offen	COR	Monika Banaš	Monika Banaš, Christia...	-	-	OKA_ZWP_TGA.rvt	Christian P...
#117	Coordination	Offen	COR	Monika Banaš	Monika Banaš, Mike Ra...	-	-	OKA_ZWP_TGA.rvt	Mike Radzu...
#115	Coordination	Geschlossen	COR	Monika Banaš	Monika Banaš, Demir H...	-	-	OKA_ZWP_TGA.rvt	Timon Broz...
#114	Coordination	Geschlossen	COR	Monika Banaš	Monika Banaš, Demir H...	-	-	OKA_ZWP_TGA.rvt	Timon Broz...
#113	Coordination	Offen	COR	Monika Banaš	Monika Banaš, Demir H...	-	-	OKA_ZWP_TGA.rvt	Timon Broz...
#111	Coordination	Geschlossen	COR	Monika Banaš	Monika Banaš, Timon B...	-	-	OKA_ZWP_TGA.rvt	Timon Broz...
#110	Coordination	Offen	COR	Marius Ruschel	Marius Ruschel, Demir ...	-	-	OKA_ZWP_TGA.rvt	Monika Ban...
#109	Coordination	Offen	COR	Jelena Petri	Jelena Petri, Adrian Chr...	-	-	OKA_ZWP_TGA.rvt	Monika Ban...
#108	Coordination	Offen	COR	Marius Ruschel	Marius Ruschel, Timon ...	-	-	OKA_ZWP_TGA.rvt	Monika Ban...
#107	Coordination	Offen	COR	Marius Ruschel	Demir Hasanagic, Timo...	-	-	OKA_ZWP_TGA.rvt	Monika Ban...

AUTOMATED PROCESS FOR THE CREATION OF THE ASSET IDENTIFICATION SYSTEM, BY ZWP (GERMANY)

In the MEP systems design process it is necessary to assign plant identification systems to the objects to be controlled in a project. These systems are used to identify components that have a regulating function and are controlled by the building automation system. The exact design of the labelling varies depending on the project but follows a consistent logic.

A			B		C			D					E				
Liegenschaftsnummer	Beschreibung Liegenschaftsnummer als Definition		Gebäudenummer/ Bauteil	Beschreibung Gebäudenummer/ Bauteil	Ebene	Trennzeichen	Beschreibung der Ebene	Beschreibung Raumnummer oder Achse	Trennzeichen	Beschreibung Raumnummer oder Achse (Standort des Objektes)	Gewerk	Trennzeichen	Beschreibung Gewerk				
	Stelle														Stelle		Stelle
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
					-	2	-						E	L	T	-	Elektrotechnische Anlagen (Starkstromanlagen)
					-	1	-						F	T	-	-	Fördertechnik (Förderanlagen)
					0	0	-						G	A	-	-	Gebäudeautomation
					0	1	-						H	Z	G	-	Heizungstechnische Anlagen
					0	2	-						K	A	E	-	Kältetechnische Anlagen
					0	3	-						N	A	-	-	Nutzungsspezifische Anlagen
					0	4	-						N	T	-	-	Nachrichtentechnik
					0	5	-						R	L	T	-	Raumlufttechnische Anlagen
					0	6	-						S	A	N	-	Sanitärtechnische Anlagen
					0	7	-										
					1	2	-										
					D	G	-										
					D	A	-										

F				G					H				I					J				K (nach Projektorde)										
Anlage	Ild. Nr. Anlage	Trennzeichen	Beschreibung Anlage	Anlagenteil/ Bauteil	Ild. Nr. Anlagenteil/ Bauteil	Beschreibung Anlagenteil/ Bauteil	Trennzeichen	AS/PRA Verteiler	Beschreibung AS/PRA Verteiler	Trennzeichen	Funktionskennung/ Datenpunkt	Ild. Nr. Funktionskennung/ DP art	Beschreibung Funktionskennung/ Datenpunkt	Trennzeichen	Ebene des zu vers. Bereichs	Beschreibung Ebene des zu versorgenden Bereichs	Trennzeichen	Raum des zu versorgenden Bereichs	Beschreibung Raum des zu versorgenden Bereichs	Trennzeichen	Klartextbezeichnung											
																						Stelle		Stelle		Stelle		Stelle		Stelle		
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	mindestens 17 zusätzl. Stellen (48 bis 64)		
A	A	-	-	-	-	Abt	-	0	0	1	-	-	Bei 1-stellig	-	A	F	-	-	-	2	2	Untergeschoss	-	-	-	4	7	-	Bei 2-stellig			
A	B	G	-	-	-	Aktor allgemein	A	K	T	-	-	-	Bei 2-stellig	-	A	S	-	-	-	1	1	Untergeschoss	-	-	-	-	-	-	Bei 3-stellig			
A	F	F	-	-	-	Arbeitsplatz/ Punkt/ Quellenabsaugung	A	P	A	-	-	-	-	-	B	E	L	-	-	0	0	Erdgeschoss	-	-	-	-	-	-	-	-		
A	G	S	-	-	-	Antrieb (Tür, Tor, Schranke, Fenster, Jalousie)	A	T	R	-	-	-	-	-	G	W	C	-	-	0	1	1. Obergeschoss	-	-	-	-	-	-	-	-	Vorgaben gemäß Grundrisse	
A	I	R	-	-	-	Außenlüft.	A	U	-	-	-	-	-	-	S	W	C	-	-	0	2	2. Obergeschoss	-	-	-	-	-	-	-	-		
A	N	A	-	-	-	Außenfußklappe	A	U	K	-	-	-	-	-	B	B	-	-	-	0	3	3. Obergeschoss	-	-	-	-	-	-	-	-	-	
A	N	A	-	-	-	Aufzugmaschine	A	U	M	-	-	-	-	-	B	M	-	-	-	0	4	4. Obergeschoss	-	-	-	-	-	-	-	-	-	
A	U	L	-	-	-	Aufzugtür	A	U	T	-	-	-	-	-	B	Z	-	-	-	0	5	5. Obergeschoss	-	-	-	-	-	-	-	-	-	
A	U	R	-	-	-	Begleitener Abzug (Laborabzug)	B	A	-	-	-	-	-	-	B	Z	G	-	-	0	6	6. Obergeschoss	-	-	-	-	-	-	-	-	-	
A	V	-	-	-	-	Batterie/Akkumulatoren	B	A	T	-	-	-	-	-	C	A	L	-	-	0	7	7. Obergeschoss	-	-	-	-	-	-	-	-	-	
A	W	A	-	-	-	Beleuchter	B	E	F	-	-	-	-	-	C	O	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	W	B	-	-	-	Brandschutzklappenmodul (BUSmodul)	B	K	M	-	-	-	-	-	T	V	-	-	-	1	2	12. Obergeschoss	-	-	-	-	-	-	-	-	-	
A	W	H	-	-	-	Brandschutzklappe	B	S	K	-	-	-	-	-	E	F	-	-	-	D	G	Dachgeschoss	-	-	-	-	-	-	-	-	-	
B	E	A	-	-	-	F90-Brandschutz für Netze nach 18017	B	S	C	-	-	-	-	-	E	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	E	I	-	-	-	Brandschutzleitventil	B	S	V	-	-	-	-	-	E	N	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	E	S	-	-	-	Brenner	B	R	E	-	-	-	-	-	E	N	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	K	A	-	-	-	Überstromsicherung mit BSK u. Rauchaus-	B	U	F	-	-	-	-	-	E	E	-	-	-	D	A	Dachaufricht	-	-	-	-	-	-	-	-	-	-



- To support the automated generation of the asset identification system (AKS), a combination of dynamo scripts and the use of type parameters is used.

REALITY CAPTURE FOR REMOTE SITE INSPECTION, BY ETHOS ENGINEERING (IRELAND)

This is a BIM Related innovation for the creation, recording and site inspection of activities during the construction phase of projects.

Due to the geographical locations and distances involved in projects within the design management group, a tool was researched and implemented to aid in the review, site inspection and coordination of these projects.

After reviewing several potential systems, the "OpenSpace" platform was selected, and this has been included in the Ethos specifications for Design Management projects going forward.

The system has several elements, and these include:

- 360° camera attached to an operative's hardhat.
- And smart phone app to connect between the 360° camera and the cloud / AI platform.
- A cloud / AI platform that acts as the processing and storage location for all the information captured during the site walks.



On-site Procedure

The process to capture the necessary data is as follows:

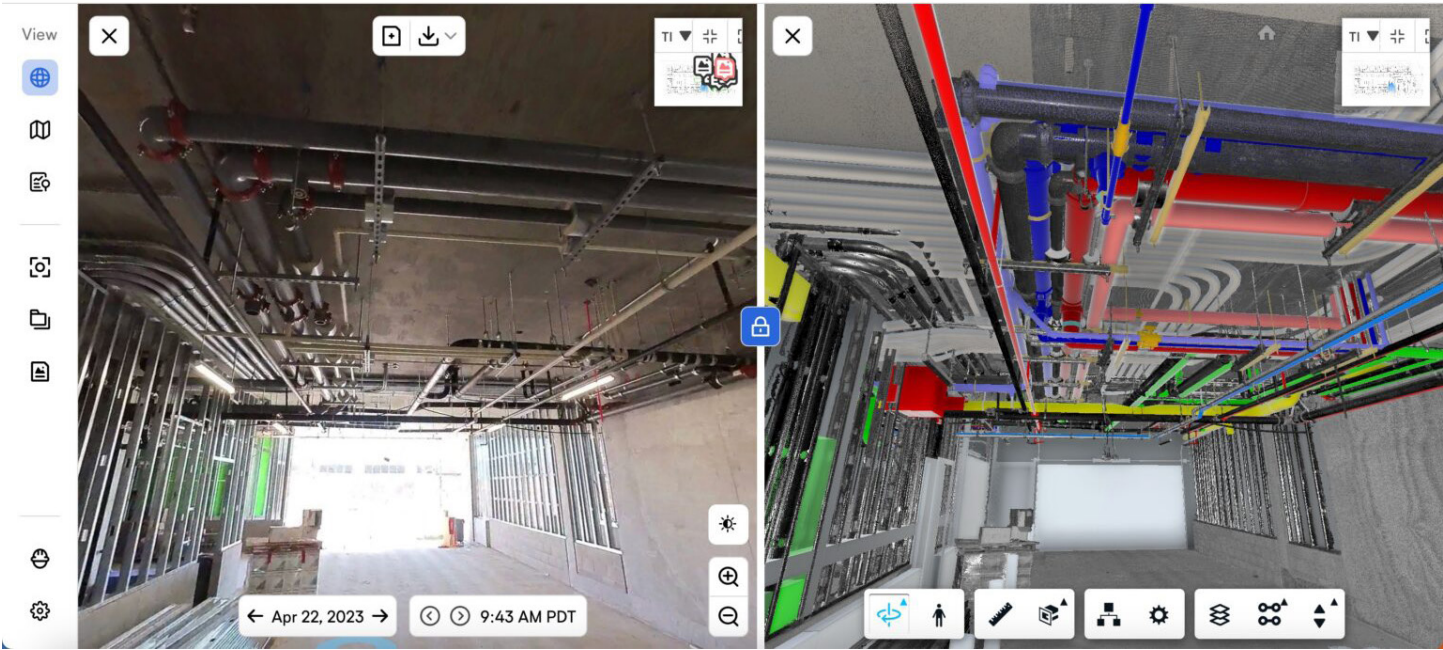
- An operative on-site attaches a 360° camera to their hardhat and sync / configures the device through the app.
- The operative then walks around the site/ project both externally and internally within buildings as necessary.
- The operative does not need to follow a pre-determined path through the project as the processing/ AI will compensate for this.
- Once the site walk is complete the operative then uploads the data to the OpenSpace platform and this information is then processed.
- Once processed then reality capture can then be viewed on any device with an internet connection.
- The site walks are then repeated on a weekly or daily basis as agreed with all parties, this allows a historical record to be kept for the duration of the project to allow progress to be tracked.

Remote inspection / Project Review

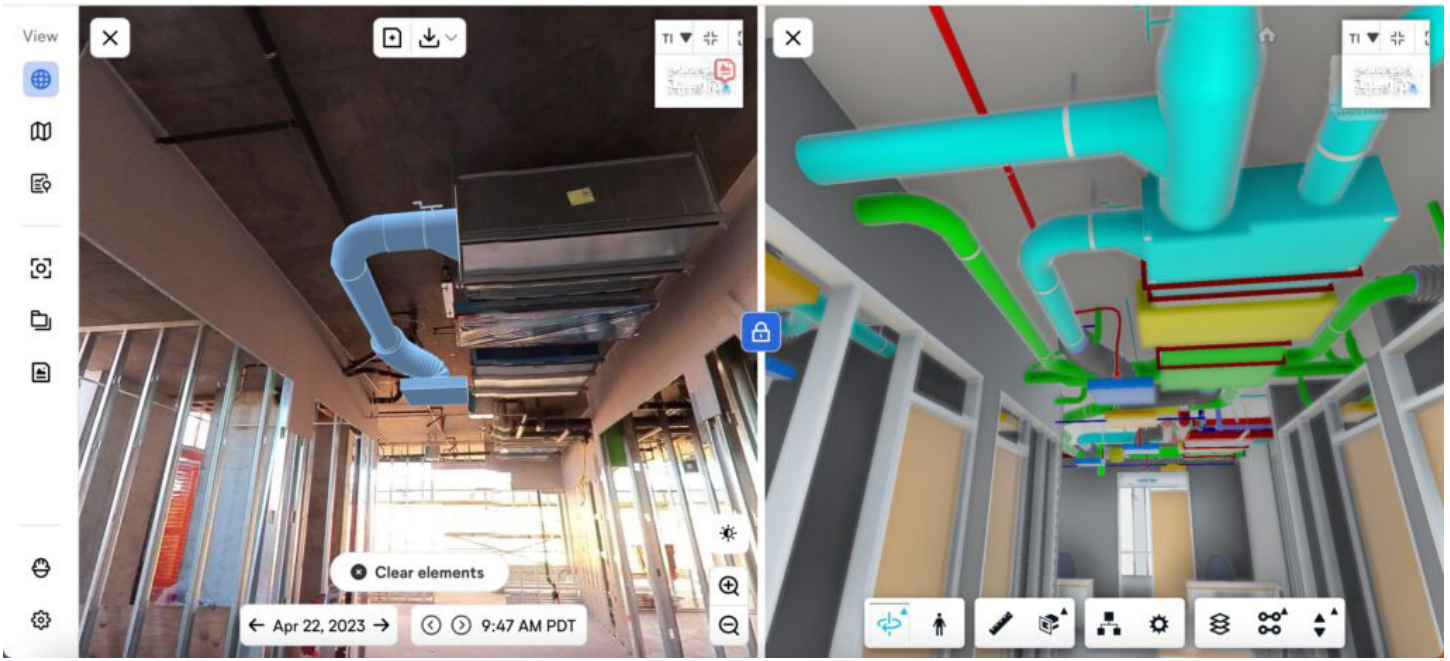
The review process off-site can then be broken down as follows:

- Any internet connected device can be used to view the reality capture data.
- The captures can be viewed on their own just as a method of viewing the project.
- The data captured from site can then be integrated with federated models to use as a comparison for model to site reviews / coordination.
- This allows for greater interactions between remote project sites and design teams while promoting frequent site captures to track progress of all disciplines.

• Site Vs Model Comparison 1



• Site Vs Model Comparison 2



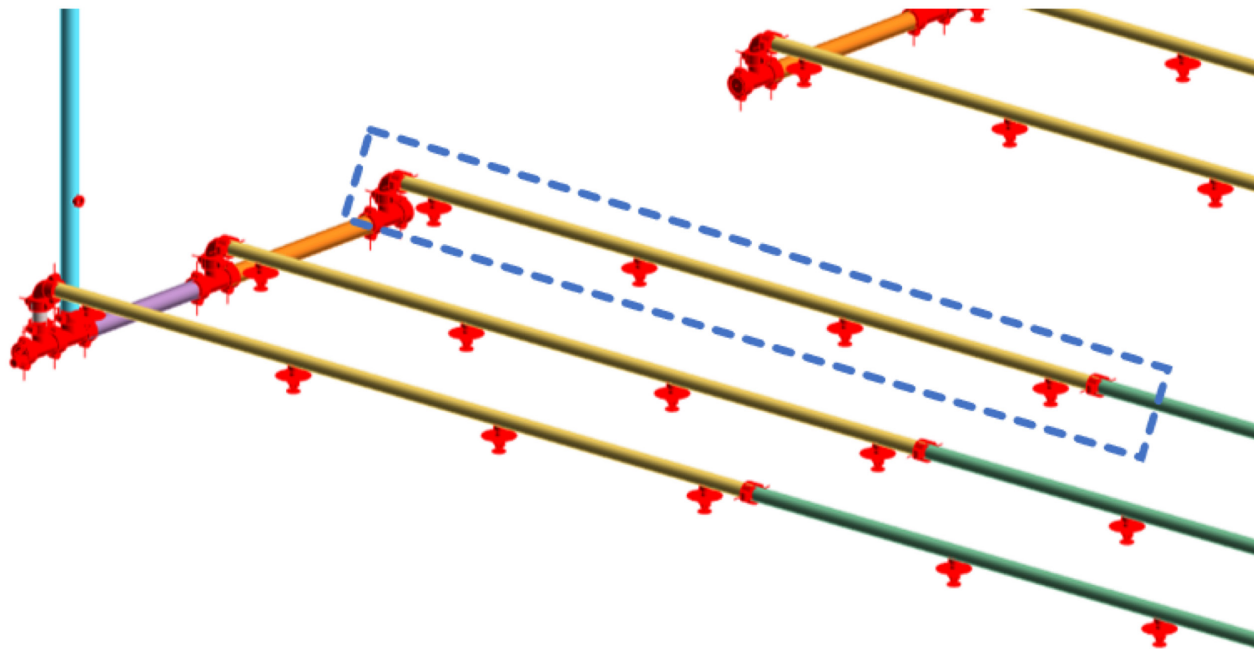
PROJECT WORKFLOW FOR PREFABRICATION DRAWINGS, BY MEPCO (LITHUANIA)

At MEPCO, we place a high priority on BIM projects to guarantee that they meet the highest standards of quality and efficiency. With the increasing prevalence of pipe fabrication in the construction industry, we have implemented a successful BIM project workflow to be able to produce prefabrication drawings for fire protection systems. Our workflow has allowed us to deliver superior quality prefabrication drawings to our clients, resulting in efficient and cost-effective construction projects.

The BIM project workflow for creating prefabrication drawings for fire protection systems typically involves the following steps:

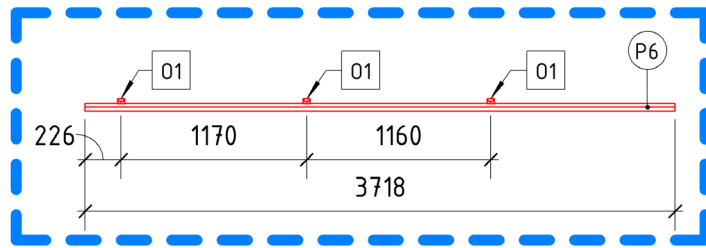
- **Initial Design and Engineering:** This involves selecting the appropriate components that will be used during the 3D modelling phase and ordered from a specific supplier, ensuring that they are equivalent to the real product; determining the layout of the system, and calculating the required flow rates and pressures.

- **3D Modelling & Detailing:** Once the design is finalized, the next step is to create a 3D model using Autodesk Revit software. The 3D model is then detailed to include all the necessary components, such as pipes, fittings, valves, supports. The level of detail will depend on the client's requirements and the complexity of the project, but most of the time, our company provides LOD 400 models when prefabrication drawings are required. This model will be used as the basis for the prefabrication drawings.



- **Fabrication Drawings:** After 3D modelling and detailing is complete, the Victaulic Tools software add-on for Revit is used to create assemblies, views, and tag the components. It's important to

mention that in-house developed Dynamo scripts play a crucial role and help to improve efficiencies on otherwise time-consuming tasks.



FA1-B002 Pipe Schedule

Tag	Name	Diameter	Length	Size	Thickness
P6	EN 10217-1 Steel Grade P235TR1 Powder Coated	40	3718 mm	48.3 mm	3.3 mm

FA1-B002 Fitting Schedule

Tag	Name	Nominal Size	Size	Count
01	BSPT Welded Outlet (Female Thread)	20	33.7 mm	3



These drawings will provide detailed information on the layout and installation of components, which will be used in the prefabrication shop to build the spools. Once the spools are created, they will be transported to the site for installation.

CLASH CONTROL IN THE CLOUD, BY GOBLET-LAVANDIER (LUXEMBOURG)

For the development of our BIM models, we use centralized models which are regularly refreshed on a shared cloud. Figure 1 shows the development of MEP networks to design a car park, including all MEP systems:

- Electricity
- Heating
- Ventilation
- Sanitary
- Buried networks

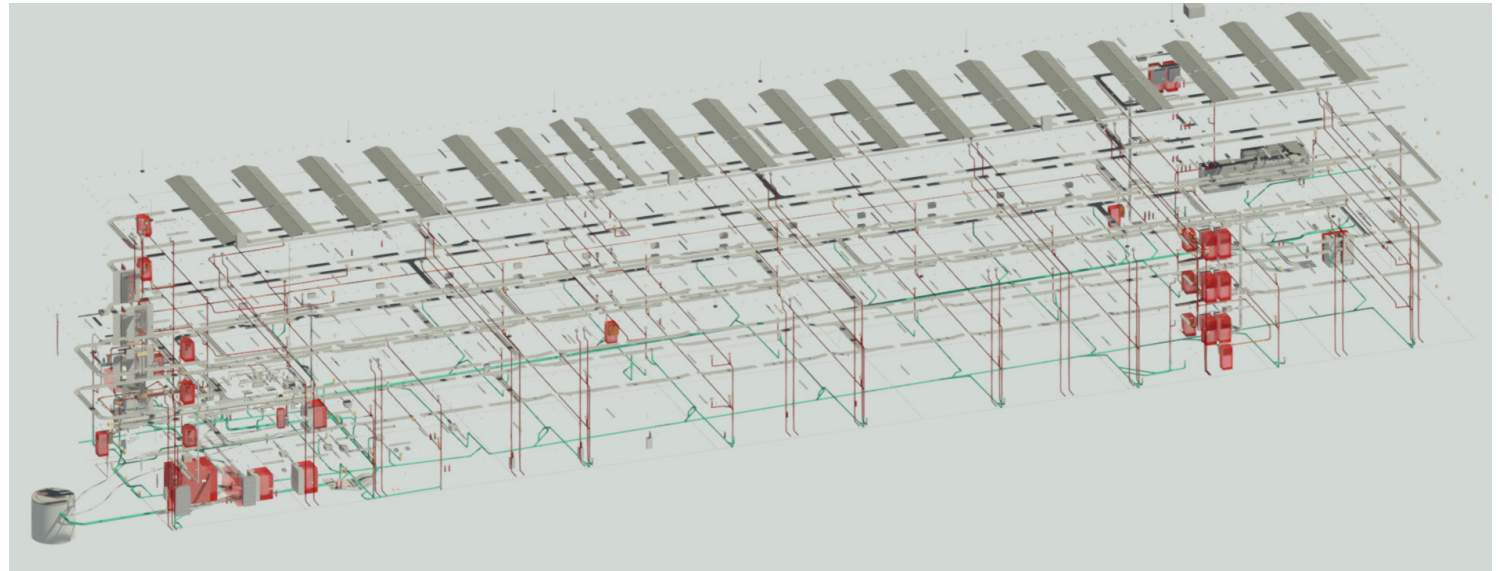


Figure 1 MEP design, BIM Level 3

In order to control the quality of our model with regard to structural and architectural models, we use a table on the cloud to monitor the number of clashes in 3D (Figure 2).

	91789_EXE_... BP&R_SCFL_... ZONDO_MA... rvaitions	91789_EXE_... BP&R_SCFL_... ZONDO_M... Chauffage	91789_EXE_... BP&R_SCFL_... ZONDO_M... electricité	91789_EXE_... BP&R_SCFL_... ZONDO_MA... SPE_HVAC	91789_EXE_... BP&R_SCFL_... ZONDO_MA... enterrés	91789_EXE_... BP&R_SCFL_... ZONDO_M... Sanitaire
91789_EXE_BP&R_...RU_Réservations 0 groupes de conflits						
91789_EXE_BP&R_... TSPE_Chauffage 0 groupes de conflits						
91789_EXE_BP&R_S...TSPE_Electricité 1 groupe de conflits						1
91789_EXE_BP&R_...rvt - TSPE_HVAC 0 groupes de conflits						
91789_EXE_BP&R_...éseaux enterrés 0 groupes de conflits						
91789_EXE_BP&R_... TSPE_Sanitaire 1 groupe de conflits			1			

Figure 2 clash detection daily monitoring on centralized model, BIM Level 3

Our provisions for voids are viewed by architects and structural engineers (Figure 3) who give their approvals before voids are integrated.



Figure 3 Provision for voids, management

The BIM models of our techniques are voluminous (Figure 4) as shown by the example of the CHL hospital, in IFC.

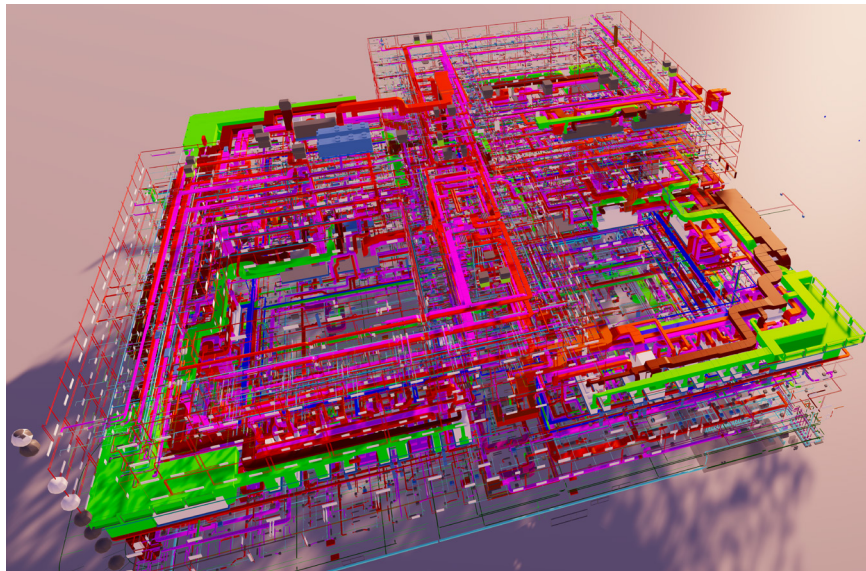


Figure 4 large IFC MEP models (200 000 objects)

To control provision for voids in our models, we use a set of rules (Figure 5, left) that we then apply in the model (Figure 5, right) to verify their integration.

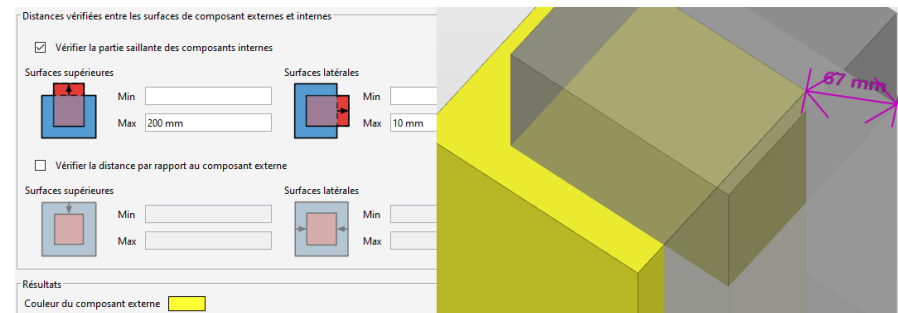
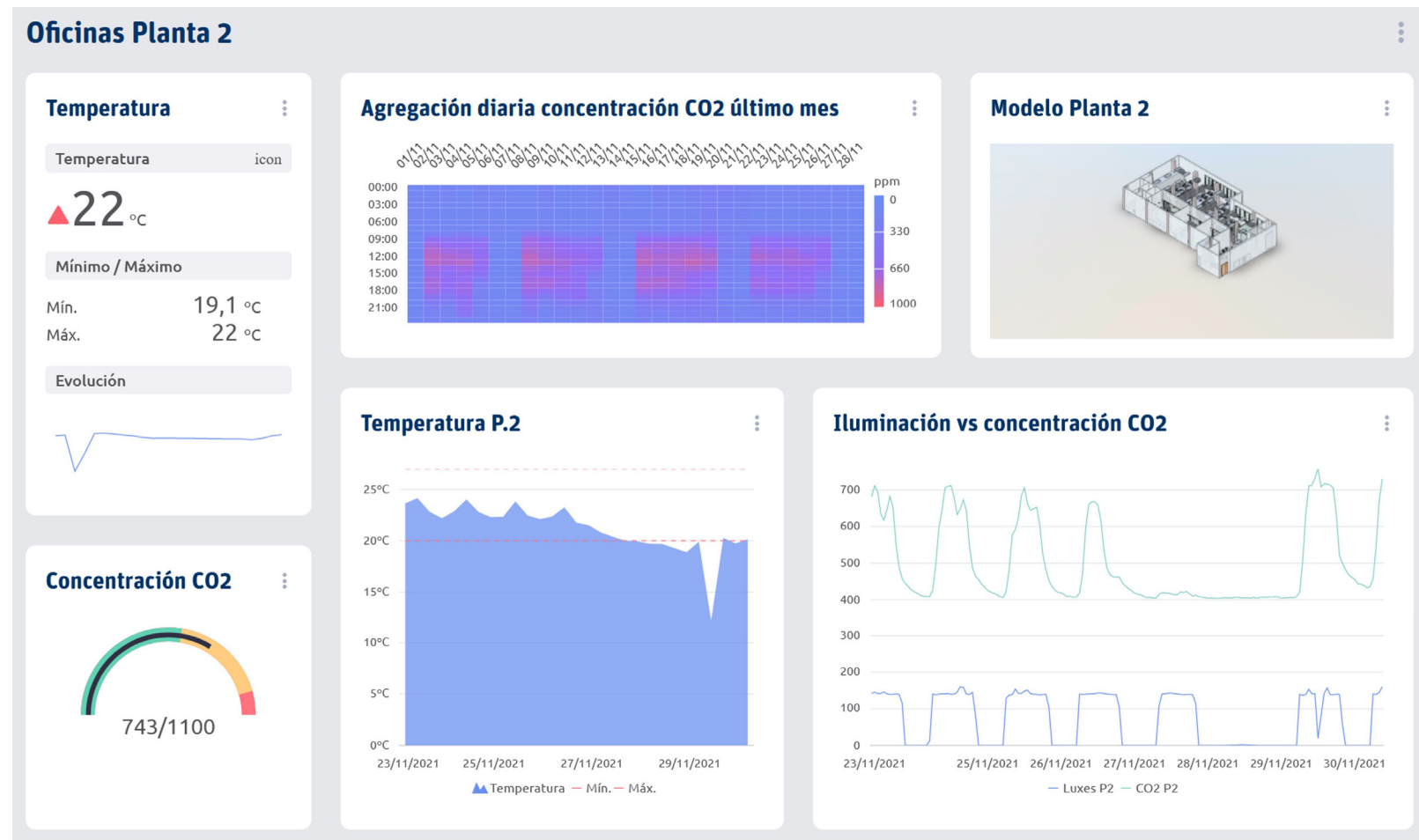


Figure 5 Provision for void, rule specification (left) and integration 3D checking (right)

A SMART BUILDING PLATFORM BASED ON BIM, BY JG INGENIEROS (SPAIN)

With the recent incorporation of monitoring technology and smart solutions in buildings, there is a need to provide a comprehensive IoT platform that will integrate the different technological solutions installed in the buildings. This platform will provide a comprehensive information analysis so the building operation can be optimized both from the owner and the final user perspective.



• Iris JG main dashboard with BIM model on the top right

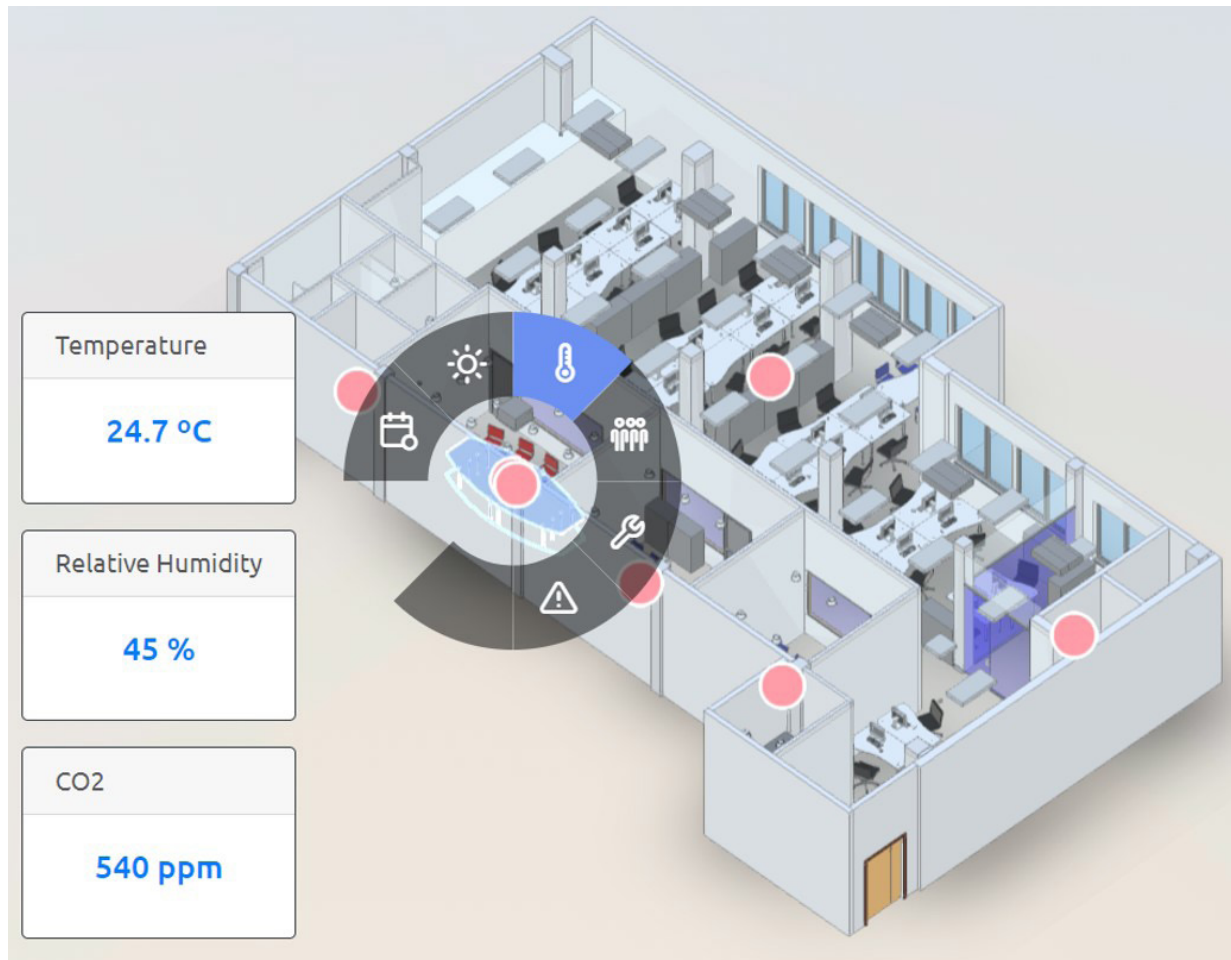
With this objective in mind, JG Ingenieros has developed IRIS JG, our smart Building IoT platform. IRIS JG collects all building data and systems data, providing one single point of access to all systems and producing building performance analytics reports.

IRIS JG integrates, among others, the following facilities:

- Space capacity and real-time occupation
- Room and facilities booking
- Indoor air quality and environmental comfort conditions
- Facility management

IRIS JG operates using the BIM 7D model of the building, both as an information display and as a point of interaction from the system user.

IRIS JG integrates the BIM model using Autodesk's Forge Viewer v7



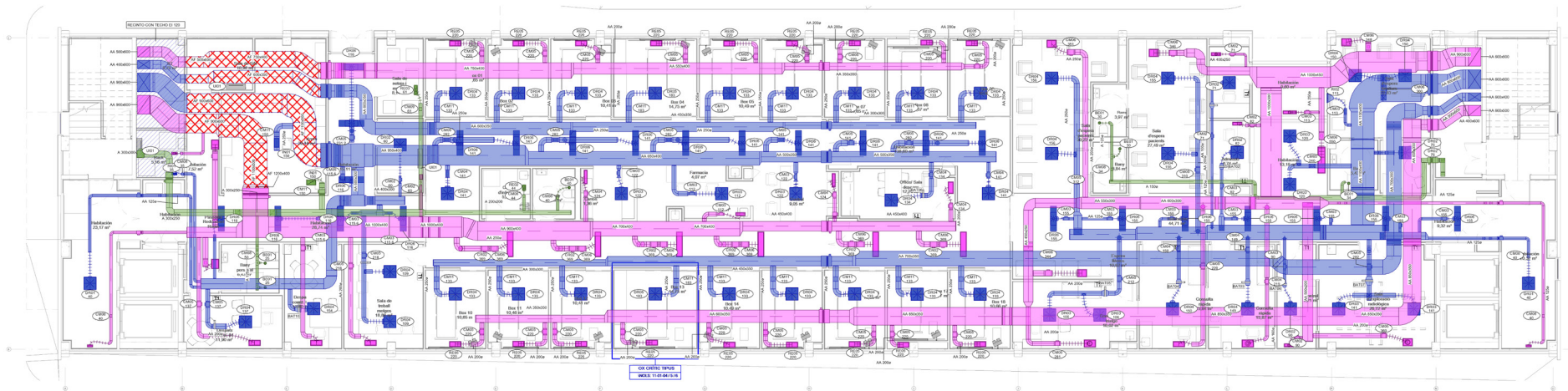
• Detail of IRIS JG real time information supported on the BIM model

BIM TO FULL POWER AT THE DESIGN STAGE, BY JG INGENIEROS (SPAIN)

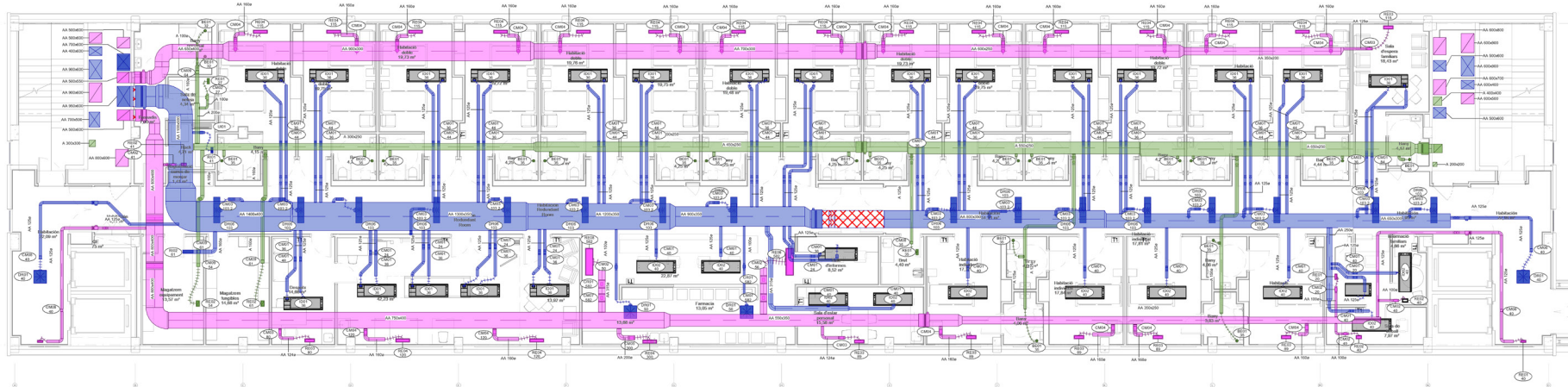
When working on BIM projects for MEP systems, we at JG Ingenieros wanted to guarantee maximum design quality and consistency, as well as having a high level of internal information. We developed the following two design principles:

- All networks and systems sizing shall be incorporated in the model.
- The different object families will include all the necessary parameters for systems calculations and future operational support.
- Sizing and critical path for air ducts and water pipes
- Sizing of domestic hot water recirculation systems based on energy losses
- Rainwater and foul water network sizing, according to different national codes
- Fires extinguishing networks calculation
- Electrical cable and tray sizing
- Electrical schematics production
- IT networks: tray and racks sizing
- BMS: program strategies according to the BIM model
- Combination of different sections of the network when using split BIM models

To achieve these two objectives, we developed the BIM (Autodesk Revit) calculation tools, completing them, and developed new calculation tools (plug-ins) on C# programming language with the Autodesk API. We chose not to use Dynamo routines as we could not guarantee enough reliability on the calculations. Now what we can do from the same BIM model is:



• Intensive care unit floor – air conditioning

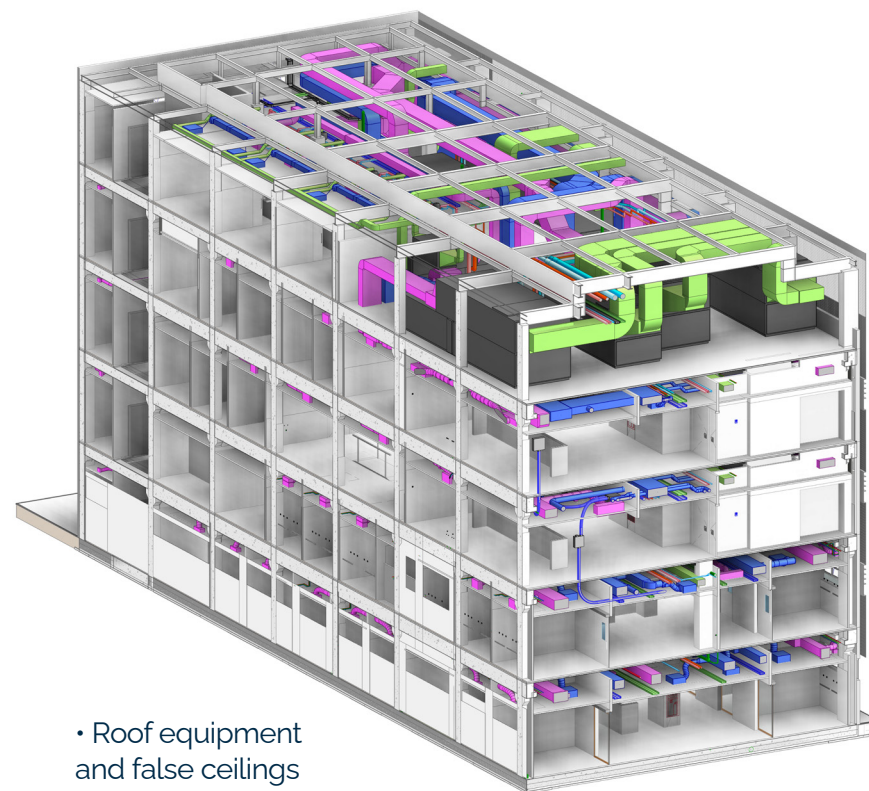


• Standard two-bedroom floor – air conditioning

With these tools available we have been able to produce high complexity projects very efficiently.

For example, we designed the MEP systems for a 4.500 m2 new built hospital extension for infectious diseases like Covid in Bellvitge (Barcelona). The hospital had biosafety strict conditions areas like emergency wards, intensive care units and isolation hospital rooms. The design and built was a super fast-track project: 17 weeks since project order to final delivery to the regional hospital authority. BIM strategy was essential in the construction strategy:

- Pre-fabrication of MEP systems in factories and workshops
- Plug-and-play equipment for easiest commissioning processes



• Roof equipment and false ceilings



ADVANCED 3D COORDINATION PROCESS, BY WALDHAUSER – HERMANN (SWITZERLAND)

The details of the coordination process of a BIM project are depending on specific factors like, amongst others, the project phase, time frame, role (overall or technical coordination) and customer specifications. Although the following description tries to illustrate typically implemented workflows, parts might differ depending on the project.

The software Revizto is used for coordination as the single source of truth (SSOT) and (since the update to Revizto+) also more and more for clash detection due to the superior ease of use and efficiency when compared for example to the clash detection system in Navisworks. Another advantage using Revizto is the simple integration of 2D plans, which comes in handy, especially when there is no 3D data available from architecture or contractors.

Furthermore, the possibilities of visualization by defining appearance templates combined with the fast setup of search sets and a selection inspector makes us focus on this software for 3D coordination.

For task and note creation outside of Revizto, a variety of software is used, dependent on project specification and/or the preference of the coordinator:

3D-Coordination	Task management and/or protocolling outside of Revizto
	

The general BIM coordination process with Revizto is presented in **Figure 1**, with a focus on:

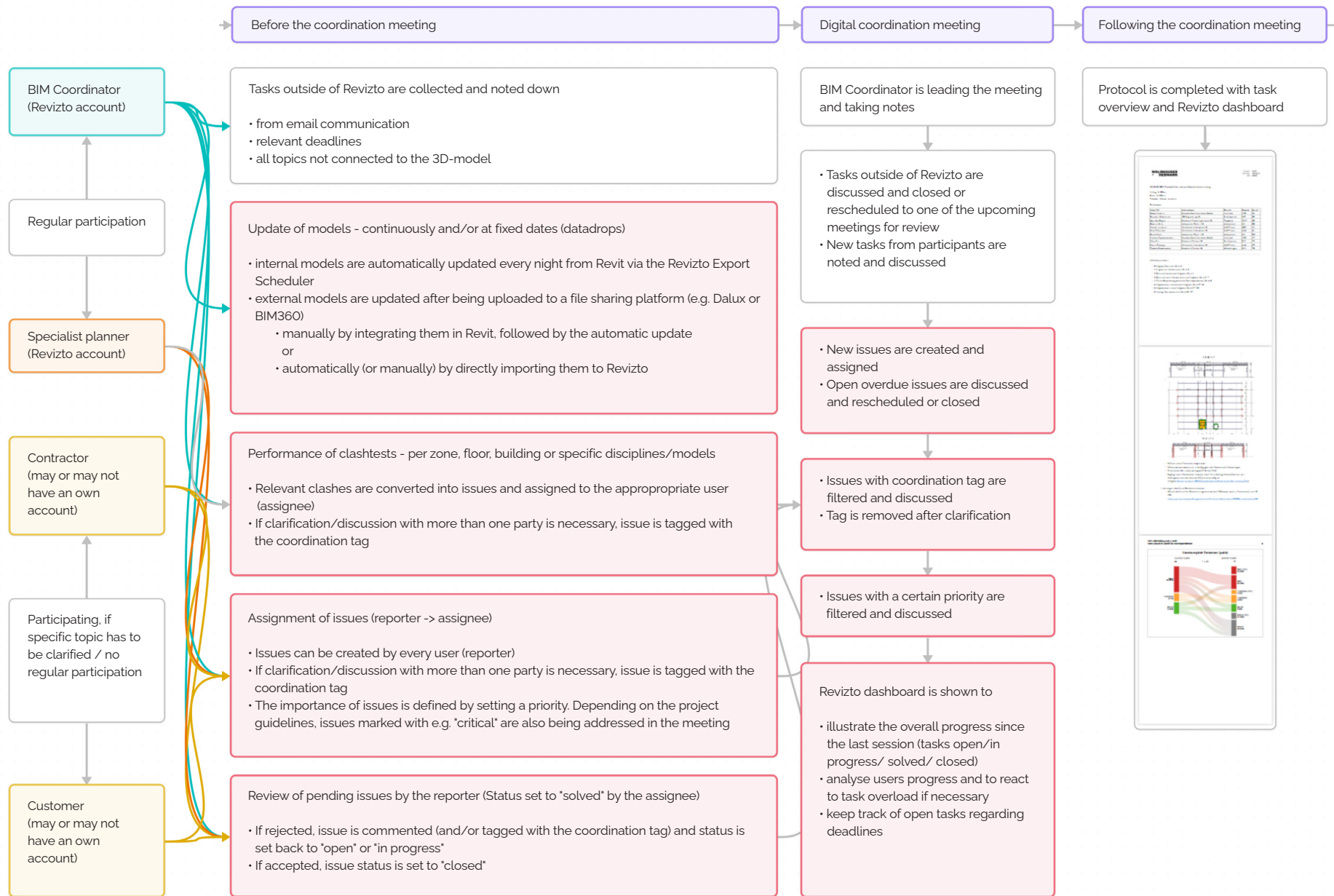
- The way in which the project participants are involved
- Possibilities of communication and task assignment
- Dealing with model updates
- Pending issues and progress monitoring

As each project has its own characteristics, to some extend multiple possibilities are shown in the illustration.

Issues in Revizto, which should be discussed in the upcoming coordination meeting, can be tagged (coordination tag, e.g. "#DCM") by every user.

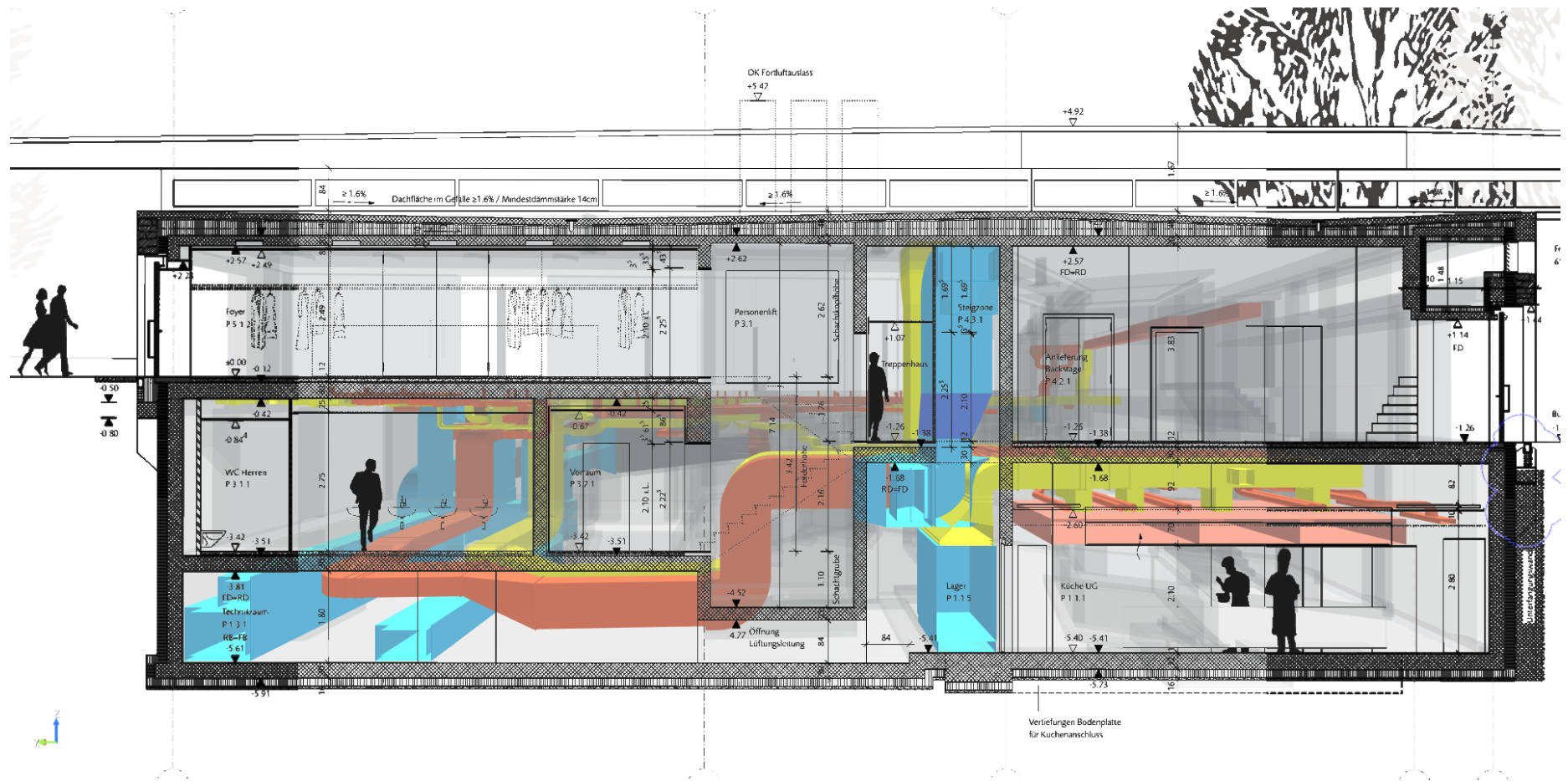
This workflow leads to a reduction in the number of emails sent and makes sure, that important issues are not overseen in the meeting, even if the reporter himself is not attending for some reason.

In **Figure 2** (page 32), we show an example of the combination of 2D and 3D in Revizto – in this example highlighting the ventilation system accessing the building.



• **Figure 1:** Sketch of the workflow when coordinating with Revizto

ADVANCED 3D COORDINATION PROCESS, BY WALDHAUSER – HERMANN (SWITZERLAND) continued.



• **Figure 2:** Combination of 2D and 3D in Revit



FIRST Q
NETWORK



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