BIMplement

Towards a learning building sector by setting up a large-scale and flexible qualification methodology integrating technical, cross-craft and BIM related skills and competences.

www.bimplement-project.eu

Report:	**D4.5 – Tools, training content and qualification schemes for BIM work place trainers _ v10**
Prepared by:	ASTUS, P.Perreau, M.Olivier
Date:	2029_06_20
Partners involved	ASTUS, and all partners

ASTUS CONSTRUCTION

This project has received funding from the European Union's H2020 framework programme for research and innovation under grant agreement no 745510

version table for deliverables

Version 1	march, 2018	Template
Version 2	November, 2018	First version
Version 10	October, 2019	Version displayed, with references for illustrations
Version 11	June 20, 2020	Final version, including input on the BIMplement kit, and English translation of Annexes 2.1 & 2.1

Table of Contents

Index des figures

Methodology for the BIMplement pack implementation

1. Executive summary

Work package 3 made a large review of available training contents and pedagogical tools links with airtightness and ventilation issues.
This D4.5 deliverable outlines the methodology that shall be applied by the BIMplement workplace trainers. It aims at helping BIMplement trainers to set up their own training programme.
First, it describes the process that BIMplement trainers have to follow in order to get a good view of the project and of the involved stakeholders. A specific table have been designed to help BIMplement trainer to set the BIM and nZEB skills of each stakeholders. This table will be improved in response to site experiences feedback.
An important focus is given to BIM training as this topic is rarely developed. Several points are presented and discussed : the BIMplement trainers skills, the guideline to adapt BIM training to a site, the adaptation of a BIM model to answer the airtightness issue, the framework for setting a training programme for on-site workers.
The Qualification Framework issued from Work Package gives a set of data that can be introduced in the training delivered on site.
In addition, issued from the site experimentations, the “BIMplement Kit” have been created to answer the needs of building companies that wish to implement training sessions, by themselves, toward their employees, during small 1hour sessions, implemented directly on the construction site.
This approach aims at alignment and harmonisation of different trainings for comparisons to be made during WP5.

2. Introduction

2.1. Reminder of BIMplement objectives

The project objectives are to enhance nZEB construction and renovation, while easy up collaboration and up-skilling of stakeholders.

- The focus will be given to two major subjects, that will have a great influence on the nZEB result : ventilation and airtightness.
- BIM modelling and BIM model use will be the essential tools that will allow all stakeholders to collaborate

The main concerned stakeholders to reach these objectives are the building companies who work on site. The training sessions will be, preferably, carried out on the working site. The training program will have to take into account the local working situations that should be improved following this up-skilling.

2.2. The two complementary approaches developed in BIMplement

Two complementary approaches have been developed in BIMplement to reach the assigned goal. Both aims at workforce development, with a focus given to building companies, and in particular to blue collars workers who, very often, have little access to training.

During the project, work package 2 and 3 have developed a methodology that links the skills needed on the construction site to implement a certain task to the training courses and tools available in the different countries.
This Qualification Framework (QF) has been established for the 2 specific subjects on which BIMplement is putting the focus : ventilation and airtightness.
In addition, the methodology will propose to "use BIM as a carrier" for this QF, by linking the QF to the BIM objects in the BIM models (Fig.1), so as to have a direct information of the skills needed for implementation of such an object. This part of the methodology will be tested selected pilot projects.

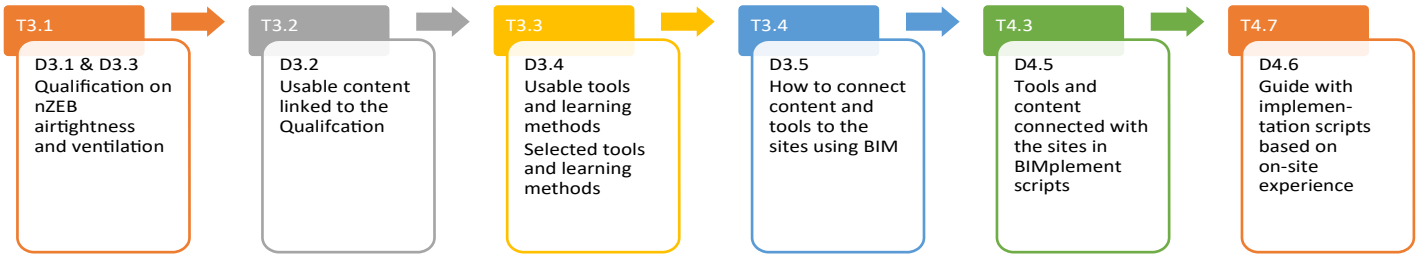


Illustration 1: From Qualification -to- a tool selection -to- implemented tools -to- usable implementation scripts (WP3)

The second approach is especially developed in this deliverable. BIM process in a construction project is considered as a very useful tool to limit design errors and conflicts between different trades. In fact, it appears that in many cases, each trade (structure, MEP, electricity, exterior networks …) know perfectly how to handle their own issues, collaboration and interface management between trade teams is a real weak point. Lack of collaboration is the origin of many problems on site where workers have to implement ill-appropriate solutions for issues that have not been foreseen at the design level, or workers to not have the technical information to do the job, or even, they do not have the skills to perform the work. This entails additional unnecessary expenses, and loss of quality in terms of nZEB objectives.

The implementation of a BIM process is a real efficient solution to answer these issues. Recent feedbacks show that up to 80% of the on-site troubles can be eliminated from the beginning if a BIM process is correctly implemented.
This means that :

- all stakeholders are involved in the process : client, project manager, building companies
- all levels are involved, and in particular for building companies, from the manager to the blue collar workers
- all trades are concerned, and made conscious of their impacts on the other stakeholders
- the whole process has to be framed by written and clear specifications

This "BIM as a tool" approach is explicated in this deliverable. It aims at presenting the different types of training to be implemented, depending on the project, the stakeholders, and their skill levels. These training are focused on BIM (adapted uses at the different phases of the project, and

in relation with the different stakeholders), but, as often as possible, demonstrations will be done on ventilation and air-tightness with the help of the WP3 (first) approach.

In their way, both approaches are perfectly complementary and aims at improving cross level and cross trade collaboration to enhance nZEB construction and renovation.
In Annex 6 : BIMplement approaches on BIM, a mind map presents these 2 approaches.

2.3. Complementary approach between D4.2 and D4.5

2.3.1. BIMplement coach and BIMplement trainers

The definitions of the BIMplement project stakeholders, with reference to the Grant Agreement, are the following :
- The 'BIMplement coach' will be in charge of implementing the BIMplement project in its territory by mobilising stakeholders, finding and documenting potential field labs and experimental sites, and by coordinating the implementation of the project in its territory.
- The pilot field labs will be national or regional BIM-learning Centres or on-site construction projects where the trainings of 'BIMplement workplace trainers' and the first tests of the tools and learning methods of BIMplement will take place. A possible additional stakeholder has been introduced : the 'BIMplement master trainer'. When it appear useful, Master trainers may train BIMplement workplace trainers who will implement on blue collar training. Such a solution has been developed in France where 30 projects are expected.
- For the implementation at the experimental sites, 'BIMplement workplace trainers' will be responsible for the training implementation on each experimental site. The BIMplement workplace trainers will receive assistance of Alliance Villes Emploi, ASTUS, and the other members of the consortium.

2.3.2. D4.2 and D4.5 contents and targets

D4.2 is ONLY dedicated to BIMplement coaches. The training element related to BIM are basic, and only drafted to give the some basic skills to the BIMplement COACHES.
in fact, in order to convince owners, projects managers or building companies that do not have basic knowledges on BIM, they may/will have manipulate a viewer to show what is a BIM model.

However, in some countries, both during the BIMplement project and later when diffusion of the methodology, BIMplement coaches AND BIMplement trainers may be the same person.
This is also why reference to the initial project diagnosis is given both in D4.5 and D4.2. This diagnostic is necessary to identify the pilot and experimental field lab ... and later on, have a global view of the projects where the BIMplement methodology will be implemented.

D4.5 is dedicated for BIMplement MASTER trainers, and partly for the work place BIMplement trainers when (and because) they are supervised by a BIMplement Master trainer.
It presents the questions the trainer has to wonder about, gives examples of what can be found in the BIM models, and explain how to present these points to the whole stakeholder chain.

D4.5 gives a detailed content of:

- how the BIMplement (Master) trainer will analyse the project context
- what should be the BIMplement trainer pedagogical and technical skills
- canvas of a BIM training course, including a whole set of the different points the BIMplement trainer may encounter when he analyses his project (§6)
- detailed list of the data to be collected and analysed , related to ventilation and airtightness (§7)
It has to be noted that §6 and 7 correspond also to what would be included in a training session for design office and project manager in order, for them, to design a more adapted BIM model for on site use
- and finally, (8), gives a detailed content of the training sessions to be given on site, for blue collar workers to use a BIM model

3. Presentation of the BIM centred training

3.1. Reminder of BIM objectives in BIMplement

The BIMplement BIM objective is quite innovative, because it aims at introducing BIM down to the working site level.
However, because BIM is not yet currently used in all countries for building projects, in addition to training building companies and their salaries, it might be necessary to organize some special awareness and training sessions for the clients and/or for the project managers.

3.2. Different type of training courses, focused on BIM learning

The BIMplement pack aims at describing the training process that will be implemented for a construction or renovation project.
The training content will be very dependent on the project context and stakeholders. This is why it appears necessary to study all possible cases that may occur.
The pilot and experimental projects will be the place to test the BIMplement methodology and test its adaptability to different contexts.
This training process may also give rise to new up skilling needs that will be shared with other actors of this BIMplement training process, namely in the fields of ventilation and airtightness.

3.3. Project classification

Based on the analysis of the different pilot and experimental projects achieved during the BIMplement project, an innovative “BIMplement implementation script” will be proposed. It will consist in four parts.
1. The project description
2. An analysis of current status quo
3. The BIMplement recipe (what and how will be addressed the BIMplement issues)
4. A post BIMplement evaluation

The pilot and experimental projects will be documented as much as possible (training session documents, BIM models, technical documents, data for BIM object, in particular for ventilation, inserted technical document both for ventilation and airtightness, and placed different BCF notes to underline some technical problems – see § 4 & 5 -…). These data will provide a large quantity of examples that will serve as pedagogical bases for the BIMplement trainers to prepare and design

their future projects training sessions.
A first version is presented as a table (Annex 3 : Table for the BIMplement project classifications), and will be filled up at the beginning of the BIMplement project by the trainers in order to present each project in context. In addition, trainers will collect all training courses and resources corresponding to these projects.
Afterwards, the so-constituted data base will propose different context typologies to the future trainers. They will be able to find those most adapted to their own project, and will be able to design their training courses based on the corresponding projects.

The parameters to be collected, and then used in the table, will range from 1 (very low), to 5 (very important) :

- the client's and project manager's expectations in terms of BIM
- the BIM model quality
- BIM skills and knowledge of the different stakeholders
- ability to use viewers and collaborative platforms
- nZEB building awareness
- ability to use numeric tools on the working site

This tool (Annex 3 : Table for the BIMplement project classifications) will be improved all along the BIMplement projects. The first French pilot projects (Arras-Zodiak, Dijon -Carrousel and Voreppe-residence) and Polish projects will be used as test.

The project and its stakeholders

4. The project context

There will be two main project families.

4.1. An architectural BIM model only

In this case, the project BIM model will be designed by the architect only, who will also provide a set of plans and documents who will specify what are the objectives to be reached in terms of ventilation and airtightness.
For such a project, the client and/or the architect are willing to set up a BIM process with the building companies, with NO obligation. The objective is to increase the companies ' skill in terms of BIM use on site and improve on-site collaboration and so final building quality.
The focus on ventilation and airtightness will be brought up during the training sessions so to demonstrate BIM use efficiency.
This kind of project will certainly be the most common for the next few years. It request "modesty" within BIM process use, but it will have a real important impact in the SME and craftsmen network.
Such a case study will be developed in different pilot projects (see D4.4). An example of adapted training programme is given in Annex 1- example of Zodiak project.

4.2. Contractual BIM process implementation

In this case, one or several stakeholders already have some BIM skills and decide to implement a BIM process under contractual document involvement that will commit all stakeholders.

The aim of the training course will be mainly directed toward building companies to make them understand the interest of using BIM models within their on-site practices. That is :

- Improve BIM models for those who will have to design a trade BIM model. The focus on ventilation and airtightness will be done by connecting the corresponding BIM objects with instruction materials, detailed implementation plans or sketches, and inspection guidelines, in order to enrich the BIM models ?
- Then, the on-site trainings will use these enriched BIM model to demonstrate the interest of using BIM on site, and explain specific technical issues about ventilation or airtightness.
- and for the other companies, use the available BIM models for a better cross-skill collaboration and anticipation, in order to easier reach the quality objectives.

Such a case study will be developed in different pilot projects (see D4.4). An example of adapted training programme is given in Annex 2 (2.1 & 2.2) : example of Carrousel project.

5. The stakeholders context

The understanding the different stakeholders present skills will influence the training contents, objectives and modes.

5.1. The client / owner / real estate manager

The client's desire to achieve a project with nZEB objectives must be real.

- The client has decided to launch a BIM process for his project. In that case, the BIMplement coach or BIMplement trainer will exchange and collaborate to specify with him his aims and how widely he wishes to implement BIM, including on-site. (specify the impact on the as-built file in the BIM protocol for building companies).
- Client usually has limited BIM skills. The trainer will have to up-skill this stakeholder either within a specific training session, or within a common session with the following companies linked to the client ;.
  - building inspection office (impact on the BIM trade models)
  - SPS (impact on the technical memorandum)
  - Organization, management and coordination (impact on the 4D-planning)

5.2. The project manager

There exist two types of project manager depending of their BIM skill level.

5.2.1. 3D architectural model only

An architect makes a 3D model, with no real BIM objectives and he makes it available to the Master BIMplement trainer.

- The trainer will modify it while introducing some data given by the on-site building companies, and so transform it in a BIM model.
- The trainer will have to up skill designers (architect and design/ technical departments) by showing comparison with other detailed BIM models, and explaining what are the client's demands, and the building companies needs in terms of collaboration and coherent BIM process.
- It will be necessary to show the different possible uses of a BIM model when dealing with ventilation and airtightness. This point will need an additional work for the trainer because

of the designers' lack of BIM skills.

5.2.2. The design team has BIM skills

The project manager team will make one or several BIM models, and has the needed skills to manage a BIM process (it may have impact on the call for tender and on the BIM protocol, if a BIM protocol is stated in the contract).
The trainer will have to collaborate with this team and give them a feedback of the building companies, once the training sessions are completed.

5.3. The building companies

There are three main families. These are important criterion on how to classify the companies so they get suitable training. General construction company having BIM skills
Such a company may wish to up skill his sub-contractors who will, so, use their acquired skill within other contracts.
The trainer's main function will be to establish the link between the model made by this company and its use by the subcontractors on site.

5.3.1. Companies who can design trade models

… but who do not yet have the means to have them used during the building phase, and often do not even present their own BIM models during the site meetings, to the on-site workers, or during the synthesis meetings.
The trainer will have to make it clear that BIM models can help in :

- anticipate the work to be done
- collaborate between the different trades
- and explain that it may be interesting to prepare specific building site BIM models

5.3.2. Companies having no BIM skills

These building companies or craftsmen will participate in a BIM process AND do not have to make any BIM trade models.
The trainer will have to present what is a BIM process and get them to understand and be able to use the main BIM viewers. The aim is to have them understand the interest of the use od BIM models on site, and, in fine, to get them ask for improvements of these models for a better on-site practice.

The BIMplement trainers

6. The BIMplement trainer skills and activities at different stages of the project

6.1. Master BIMplement trainers and on-site BIMplement trainers

Master BIMplement trainers are, first of all trainers, and on-site trainer for blue collar workers.
If there is no need for additional trainers (for instance during the BIMplement project), then they will have to do the job dedicated to Master trainers and on site trainers.
When it appear useful, Master trainers may train on site trainers who will concentrate on blue collar training. That is what will be developed in France where 30 projects are expected.

In addition, BIMplement MASTER trainers have to make a complete analysis of the project that will be use on pilot or experimental sites, as presented in D4.5, §6,7 and 8)
Depending on the countries, there might be a need for 2 types of BIMplement trainers :

- Master trainers: there will be at least 1 per country. They will prepare the training BIM models, supervise and provide support and advice to trainers from their country/region to conduct experimental projects. They will also be able to intervene on the experimental sites.
- BIMplement trainers who will intervene on the experimental projects. They will be trained by the Master trainers.

6.2. Preparation of pedagogical content

In order to prepare the pedagogical content, the BIMplement Master trainer must be able to :

- take receipt of the BIM models to check their usability
- decide which tools to be used – if no indication in the BIM protocol
- read through the complete set of the project files to target their possible uses in relation with the BIM models
- identify the specific points related to ventilation and airtightness that will be useful for exchanges with on-site workers
- be able to draft a first 4D planning

If possible, and in addition, possibility to improve the model with the help of a trade software, or to design a specific BIM model :

- architectural model and ventilation model
- which need special skills to use a model synthesis software

6.3. Design a BIM introductory training course for building companies

In order to prepare a course for companies, the BIMplement trainer must be able to :

- help companies to include the BIM demands in their practices
  - ensure they understand the BIM protocol demands
  - assess the companies skills to propose adequate training
  - during the on-site synthesis meeting, help implement collaboration on the BIM subjects
  - propose the use of BIM site work tools, such as 4D-planning
  - help building company to make their as-built BIM file
- underline the ventilation and airtightness stakes, and show how BIM can reinforce the necessary collaboration
- the acquired skills should allow the companies to be able to answer later call for tender including a compulsory BIM process.

6.4. Training of on-site stakeholders

In order to give on-site training session for companies, embedded in the working time and conducted on an on-site room, the BIMplement trainer must be able to :

- ensure the on-site stakeholders understand and implement the BIM process
  - explain how to use viewers and collaborative platforms using tablets
  - propose a communication method within the models (‘BCF’ files)
  - help organize on-site meeting based on BIM models and tools (4D-planning) to enhance

collaboration around BIM trade models
    - shape “quality” and “security” tools linked to the models
    - propose on-site tools linked to models (special software for tablets)
- collect the precise needs of the different on-site trade stakeholders with the objective of experimenting training session under real working situation :
    - what model data to be used on the working site ?
    - What kind of models
    - what are the different trade requests
    - what interface requests
- adjust the BIM process following the on-site workers feedback

Generic training programme on BIM

7. Pedagogical BIM contents canvas, to be adapted to each training programme

7.1. Preparing the training courses

When a BIMplement project has been identified, the BIMplement trainer makes a diagnosis of the construction or renovation works, in order to « tailor make » as much as possible the training sessions.
This chapter will explain how to handle the BIM models, and present it to the site stakeholders. The following §7, will explain how to go deeper in terms of ventilation and airtightness.

7.1.1. BIM specification analysis

Because this project is due to use BIM models, it is compulsory to analyse the BIM specifications that frames the BIM process.
Note that these specifications can be either very comprehensive, or very light.

- Specifications drafted by the client : BIM specification
    - they are intended for the project manager
    - they specify the client expectation in terms of
        1. demands in terms of BIM use at the design phase, execution phase, on-site use, commissioning …
        2. contents of the BIM as-built model, in particular maintenance and building operating
        3. project monitoring during execution and in use
- specification draft by the project manager : BIM protocol
    - it is intended to the design offices and to the building companies
    - The Protocol’s key objective is to enable the production of BIM models at defined stages of a project. It also supports collaborative working, requires the appointment of a BIM Manager and enables common standards or working practices to be made an explicit contractual requirement.
    - It requires that everyone producing or delivering information models on a project follows the same standards and ways of working and has the clear right to do so.
    - there are two editable appendices that makes the standardized document relevant to a project:
        1. Model Production and Delivery Table: This must include references to all building

information models that are required by the Employer at each stage of the project.
2. Information Requirements: These should detail the information management standards that will be adopted on your project.

Because the BIM protocol creates additional obligations and rights for the Project manager and the contracted companies, companies will have to :

- perfectly understand what are their requirements from the BIM protocol
- bring responses to the BIM protocol

7.1.2. BIM models analysis

To make the project diagnosis, the trainer has to:

- Get the project BIM model(s) (with the agreement of the client and of the project manager
- Analyse these models, in order to see how they could be used for the different training sessions on the work site
- Collect and analyse all the technical documents, with a special attention to the air tightness and ventilation issues
- Detect and identify the possible ventilation and air-tightness "weak points", and the solutions proposed at the design phase (attached documents, technical instruction, ...)
- Plan to possibly use a 4D planning with the « Navisworks » software directly made from the models; or with the use of the existing planning made from « MS-project ». The implementation of a 4D planning is easy and can be done after a short training (see III.3)
- Check the compliance of the BIM models with the BIM protocol specifications

Special issue about Navisworks :
All models, made by any BIM software, can be exported through IFC format, and therefore be open and read with a freeware viewer.
But, when a model is designed with REVIT software (RVT format), it can be directly integrated in the Navisworks Manage software (free of charge for trainers in UE), to be used in Navisworks Freedom by all the project stakeholders.
The interest in Navisworks Manage choice relies on the possibility to achieve a 4D planning by using the work done in MS-project, and by making it visible to all actors with Navisworks Freedom (which is a freeware). Different types of models can be imported in Navisworks Manage (IFC ; RVT …).

Special issue about 4D Planning
The implementation of a 4D planning is easy and can be done after a short training.

Illustration 2: special issues about Navisworks and 4D planning

7.1.3. Specify the expected results in terms of energy efficiency

Once the BIM specifications are analysed, the technical specification enclosed in the companies contracts will also have to be analysed by the "main trainer" in order to make clear the requested technical and quality result of the building:

- What are the compulsory expected results ?
  - is there an energy or global building quality label to be obtained ?
  - What level is requested in terms of building or ventilation duct airtightness ?
  - What will be the commissioning control tests for ventilation and airtightness ?

- Extract from the thermal study and calculation, and from the 2-D and 3_D models, the retained technical solutions
  - choice of the ventilation system
    - specification documents about ventilation
    - 2D and 3D plans of the ventilation system
  - technical solutions for airtightness
    - is there a generic document for all batches ?
    - Is there an airtightness technical detail book ?
    - Are there specific specifications for each batch ?
- Check the airtightness and ventilation BIM model accuracy

Based on the detailed analysis of the specifications and BIM models, the trainer will choose the proper training program type depending of the project classification (see table under construction, first draft presented on November 26, 2018, in Paris)

7.2. Possible upstream training of the clients/owners and of the project manager

Training sessions for the clients/owners (contracting party) and/or for the project manager are not really in the range of BIMplement actions. However, for a range of project, these stakeholders may need to be up-skilled, or at least get some awareness about BIM.
Awareness campaigns will be organized by the BIMplement coaches. (see D 4.2).

7.2.1. common contents for both clients and project managers

The objectives are :

- • Share a common « BIM culture » and increase the on-site use of the 3D-model : how to bring the companies and their salaries , craftsmen … to use 3D model all along the construction, going from the initial meeting with the client and project manager to the on-site training and coaching (to be specified on a case-by-case basis)
- Demonstrate the interest of using BIM on work places
- Bring the client to introduce a precise BIM process on site
- Make a presentation of the BIMplement training pack

The key speaker in these meetings is the “BIMplement workplace trainer” or the « BIMplement master trainer ».
The training session for these stakeholders can include :

- Explain the interest to implement a BIM process on the construction site, including extensive use of the project BIM models, to achieve a better construction quality
  - For the different site work meetings,
    - with all the building construction stakeholders
    - to better understand what they have to implement in collaboration (Lean management ?)
  - For the everyday work of all site work stakeholders
    - with the reading of the BIM model and its data : Assembly, quality, security and so on…
    - With a special focus on ventilation implementation and airtightness result

- Show that to achieve the first goal, it is compulsory for the project manager, and his engineering design offices to
  - Accept to improve/adapt BIM model design and organize the different BIM models and include information, memos, documents …, in order for all the construction site stakeholders to use the models more efficiently
  - Accept the feedback of the construction site stakeholders (construction companies, craftsmen, …)
- show the interest and how to make a more intensive use of BIM model on site, for instance :
  - during the different site work meetings, with all the building construction stakeholders, better it will help them to better understand what they have to implement in collaboration
  - for all worksite stakeholders everyday work
    - BIM model and its data consultation : Assembly of parts, quality, security and so on…
    - With a special focus on ventilation implementation and airtightness result
- Offer the possibility to all actors of the construction site :
  - to communicate directly with the engineering design office with the help of the BIM models (for example, with the use of BCF notes to get complementary information, or report a problem),
  - to participate and enrich the final return of the as-built BIM model for the facility management
- Show that a BIM model can be a real help for on-site general layout of the building, both for the initial layout implementation with a laser, and to check execution layout with the same type of tools

These goals are technical, but they also aim at a social enrichment and recognition of the different workers on the site.

7.2.2. possible additional training for the client

The objectives may be to accompany the client in the implementation of a BIM process for his project :

- help in the drafting/adaptation of BIM specifications, and export a table of BIM objects with their properties
- specify/draft a facility management oriented strategy, which include to also take into account the execution phase

7.2.3. possible additional training for the project manager (architect, design office…)

The objectives will be to help the project manager and his team to develop a BIM model that can be efficiently used on site, and by all stakeholders, including blue collars :

- explain how to design 3D model typology so to stimulate their use by the on-site stakeholders and building companies
- demonstrate that the project stakeholders have different BIM objectives and processes, for example, for MEP :
  - the architect design a generic MEP-ventilation model with ARCHICAD or ALLPLAN
  - the HVAC technical design office makes regulatory compliant model (up to which detailed level ? What links with the other models ? Blockout size and position ?)

    - the construction company design office make the final design, with industrial product , and makes modifications along with the foreman feedback,
    - the foreman and workers on site have
        - to find informations in a BIM model for all trades, and be able to ask question to the design office
        - search for weak point with attached documents or memos,
        - improve quality through on-site pictures of these specific points.
    - as-built (final) model. Who makes it ? With the help of whom ?
- present different example of MEP model to understand what can be expected of this trade model, and apply this process to ventilation and airtightness

In addition, it may be useful to make clear that the implementation of a BIM model on the worksite may request new technical and cultural skills from the design office : the foreman and his workers will not use all data used by the design office, but may need additional information.

Example with the airtightness issue :

- explain how to organize/implement an airtightness BIM model ?
- Be able to answer the following questions (see Ill.3):

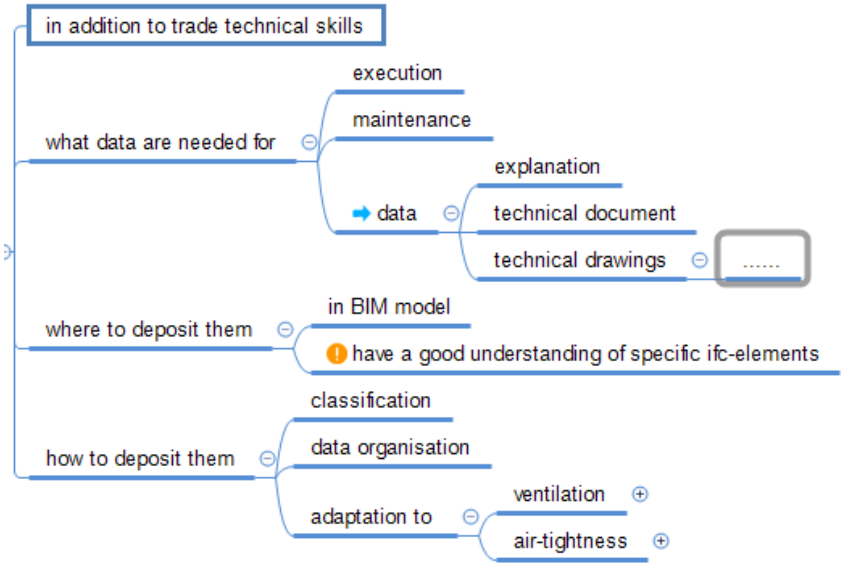


Illustration 3 : data in a BIM model

- understand how this airtightness model can be used
    - by the general foreman to manage his staff personal skills,
    - and by the blue workers themselves
- explain why and how to adapt a HVAC BIM model to the needs of all stakeholders on the construction site (foremen and blue collar workers)
    - HVAC includes plumbing, ventilation, heating, electricity, branch pipe, …, be sure that all possible BIM trade models will be able to use/get good information (blockout, branch pipe, …)
    - Reminder : BIM models may also include implementation of : Acoustic, fire protection, indoor air quality (for example : cap for ventilation air duct during construction) …

7.3. Before the on-site work starts : training the contractors (one day)

The workplace site has been selected, the trainers have been trained, the diagnosis of the project has been done, the models and the 3D planning are available.
The next step is a one-day training for the managers of the selected bidder construction companies.
This one day training is given by the « BIMplement master trainer ».
Annex 5 : how BIM can improve nZEB presents a mind map describing the issues and answers to be presented.

7.3.1. the on-site BIM use stakes for building companies

The building companies context may be different in France and in other countries.
Presently in France, BIM is used in a certain amount of project, but almost only at the design phase by the project manager. Only part of the building companies (in general, only large national companies) will design their own technical BIM model, corresponding to the products and material they will use
And almost NO building companies bring this model on site. The reasons are numerous. Among them :
- the foremen and blue collar workers do not know what is a BIM model, what can be done with it, have never seen one, and do not know how to use it,
- the company manager who have not yet introduced BIM in their companies are in the same case as above,
- the companies who uses BIM at the design phase do not know/understand why it could be interesting to use the BIM model on the site work
- in many cases, the BIM model has not been designed for a use on site (by the project manager team or/and by the company design office). So the BIM models will not be that easy for a use on site (no explanations, no attached technical documents, ...)
- and in many cases the BIM models have not been controlled, and the conflicts have not been correctly analysed
- the clients also are not aware of how a BIM model and an as-built BIM model can improve the final quality of the building. so, they do not include the proper requirements in the specifications,
- same with project manager who do not draft proper BIM protocols,
- .....

7.3.2. The initial training for building companies

The objectives are :

- Make clear that BIM model should be used on site
  - Give the trainees (who need it) the BIM backgrounds and bases
  - Convince the trainees of the interest for using BIM models and 4D planning to manage the project and to improve coordination between the trade bodies.
  - Have the company understand the importance to master the ventilation and airtightness issues for the project implementation success.
  - Share the project diagnosis, which has been done by the « BIMplement master trainer »
- organise the BIM training sessions
  - Make a presentation of the training sessions that will be organised on the work site.

- Organise the planning (and financing) of the training and coaching sessions on the work site (see Ill.4)
- Select the white and blue collar workers who have to be trained (if not all of them).

When/at what phase can the BIMplement training sessions be prepared and organized?
• Either upstream, when the BIM process is under development
in that case, participate in the development of the BIM protocol, and make some proposals that will be tested during the BIMplement pilot or experimental project .. and will help setting up a BIMplement protocol.
• or downstream, when the building companies are designated and start implementing the previously specified BIM process.

Illustration 4: optimal schedule for training

- Organize the BIM environment on site
  - install a "BIM barrack/place/container" on the construction site, including a minimum equipment : video projector, dedicated computer, tablets, …
  - develop the use of the project BIM model during the work site meeting, during site visits, and – by the blue workers – during product and system implementation
- Show the other possibilities for using BIM
  - on-site security : installation of scaffolding, transportation of equipment on the construction site
  - use of the BIM model for the site management, through table export
  - communication between the design offices and the construction site
  - participation of the construction site stakeholders to achieve the as-built model

Remark : All companies are concerned by the BIM process, but some are more concerned than others : there is a difference between the companies that are only « BIM users » and those who have to build and provide « Execution » models.

7.4. During project execution, on the construction site, training for the companies management staff.

The trainer is the « workplace trainer ». Training session are dedicated to foremen, and to the building companies management bodies and design offices. In addition, the trainees have to belong to different companies because the training courses on BIM must be designed for the whole stakeholders chain and will aim at making them aware of how BIM can help cross-trade and cross-level collaboration for a better nZEB quality.

Depending of the employees' role in the company, they will have specific needs and action in front of a BIM process (see Ill.5).

The objective of this first training session will be to understand what means "BIM":

1. to learn how to manipulate Viewers
2. to understand the project structuration, and to understand its digitization
3. to enrich the models with attached documents in order to improve information needed on the site

4. to develop the collaboration between the company or the project manager design office and the foremen on site so that the model is also designed according to the uses that will be made on the site
5. to develop collaboration between trades, especially at the interface between batches and in particular on the lots related to ventilation and airtightness
6. to learn how to export quantities from the models to make or to check orders
7. to learn how to develop and use a 4D planning
8. to create self-check sheets related to model objects
9. to understand the issues of digital as-built models and learn how to do it, including the insertion of photos or descriptions.

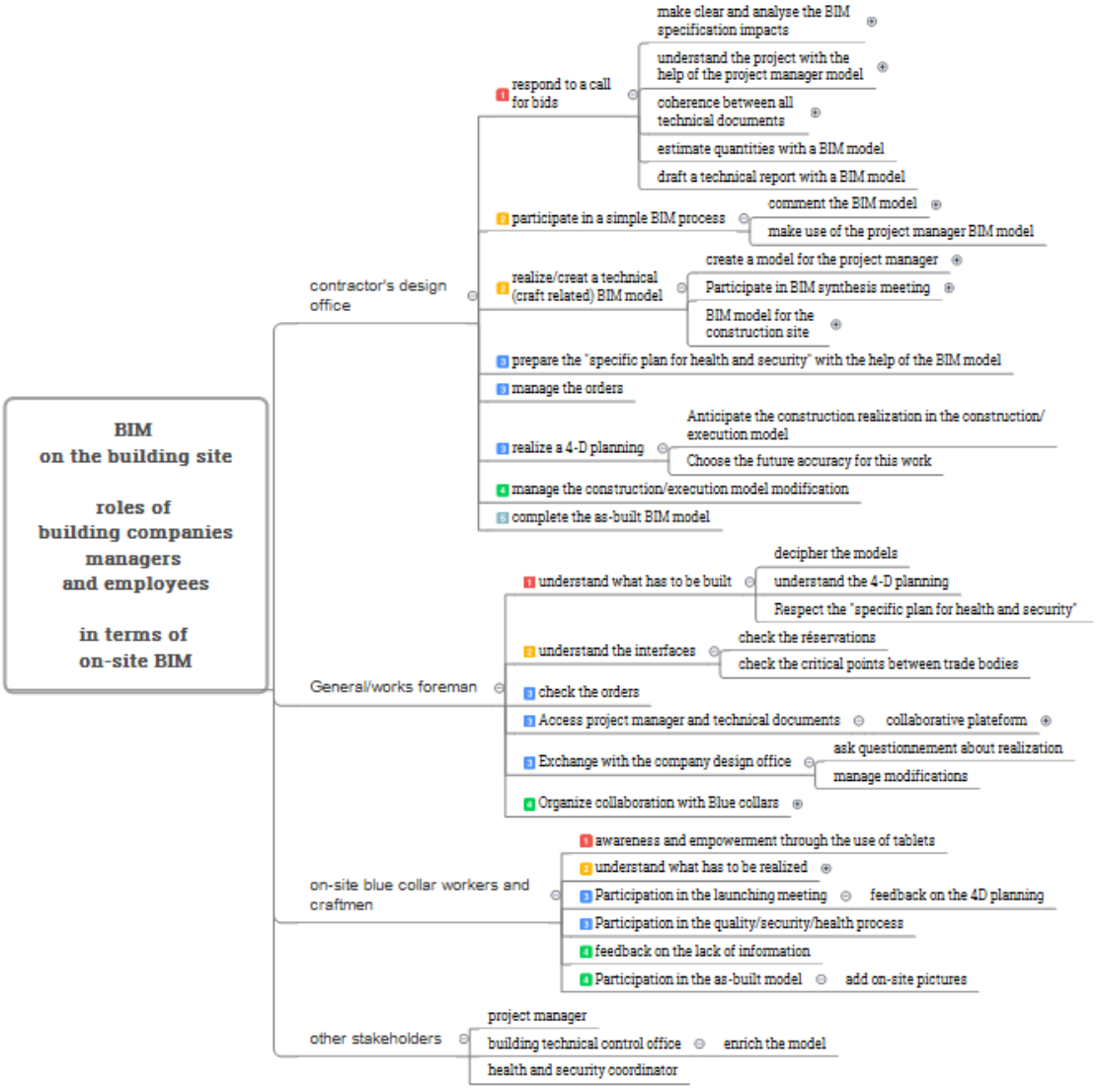


Illustration 5: the building company involvement in a BIM process

A more detailed chart is given in Annex 4 : BIM and building companies.

From the first experiments realized during the first year of the BIMplement project, it appears that training for the management staff of building companies has to be realized in two steps :

1) give a good level of understanding on what is a BIM process and on the impact of a well adapted BIM model for a better implementation on site
2) put the focus on airtightness and ventilation

- link the objectives to be achieved about airtightness and ventilation with the answers that can be given by a BIM model
- show how a “good” BIM process and BIM model can help in the management of the interfaces between airtightness and ventilation system and all other batches
- explain, with the BIM model, what are the needs of the on-site workers, in terms of data and information.

7.5. Training sessions for the on-site workers

These training sessions are provided by the « workplace trainer ».
They combine several half-days per group of 10 learners (maximum) with a mix of state bodies, and group and individual accompaniments.

7.5.1. First session

The objectives are :

1. learn how to manipulate the models of the building site with a viewer and a tablet
2. learn how to find information on models
3. learn how to communicate and collaborate from the models
4. understand how BIM can be useful for site operations.

The material and teaching tool are one tablet for 2 learners. Training is conducted in an on-site training room (meeting room)

The whole training will be oriented, for the practical part, on:

- the objectives to be achieved in the context of airtightness
- the management of the interfaces between the ventilation system and all other batches

7.5.2. Coaching of on site workers

After the first session, the trainer gets on the worksite (possibly on Monday morning) for a duration that has been fixed during the preliminary diagnosis. This session breaks down into 2 sequences of a few hours each:

a) Sequence 1

Objectives are to learn to use BIM daily as a collaborative exchange tool to:

- Prepare and coordinate work on site
- Anticipate the interfaces between bodies of state
- Perform work safely
- Check the quality of the executed work
- Use the 4D schedule

The attendance is all the employees trained during the first half-day, including the on-site team leaders.

→ Materials and teaching tools

- Computer with 4D planning software
- Tablets
- Video projector and screen

These materials are stored in the "BIM shack" which can be a secure part of the meeting room of the shipyard. It is in this room that the training takes place.

b) Sequence 2

Objectives are to check that trainees understood the training given during the session and could use BIM for their every day work.
During these sessions, additional explanations may be given, either in small groups or individually. Several similar sessions may be needed to drive all on-site workers to properly use BIM models on site.
A first feed back can be done to collect the remarks and opinions of the actors of the building site about the BIM models, in order to communicate them to the design office.
The attendance is all the employees trained during the first half-day, including the on-site team leaders.

7.5.3. Half-day debriefing with on-site trained staff

Before the end of the project, all the trained employees and the project management are gathered for a debriefing.
The objectives are to collect feedback from trained staff, in particular requests for improvements to BIM models and their data.
The attendance is constituted of all persons who have followed the training.

7.5.4. Assessment session after the end of all training session on site

This phase will be the last intervention of the trainer and will close the training operation initiated and organized with the managers of companies.
The objectives will be

- Learn from all the trainings to improve the contents and methods
- Collect remarks and comments of interest from site stakeholders regarding the models and their data
- Review and validate the condition of use of the BIM process on the construction site

This shared assessment between all BIMplement trainers will propose elements for improving the BIM processes and finalizing a BIMplement protocol.

Evaluation criteria will be

- acceptance by the owners, the project manager and the contractors, and especially craftsmen and small building companies and their employees, of the BIMplement process that has been implemented
- availability and quality of BIM models
- availability of detailed documents for the implementation of BIMplement processes on site
- measured or observed quality improvement

The attendance is constituted of all persons who have followed the training

- Project client/owners
- Project manager and his design teams
- company business leaders, design team and site managers

- Representatives of the various trainees trained
- Site trainer

This session is led by the BIMplement Master trainer.

8. General questioning when drafting a BIMplement training course in relation with ventilation and airtightness

This chapter addresses directly the question of ventilation and airtightness, when using a BIM Model. It aims at presenting to the Master BIMplement trainers the list of the point to look for in the BIM model in order to check its quality and ability to deal with these questions.

The points here addressed can be applied to multiple trade target : Building company managers, Building company design office, Site manager & foremen.
However, the contents, the points themselves, and the level of detail to be presented will depend on the public skills and project complexity.

This chapter will be divided into 5 steps

1. Manage the data system
2. How is the “ventilation” batch incorporated in the BIM process steps ? This point includes, both, how ventilation has to be implemented, and the checking of the BIMplement methodology (Qualification Framework) in terms of corresponding learning content.
3. Understand and analyse a MEP model
4. Impacts of a MEP model on the other BIM models
5. Check the airtightness weak points, with the “ifc_opening”

8.1. Manage the data system

The process is base on on point : always start from the BIM model objects, and its data

- What data have to be incorporated ? (see lll.6)
- Who enters these data ?
- who uses this information ?
- What skills are needed to incorporate / read these data ?
- What knowledge is required to get these skills ?

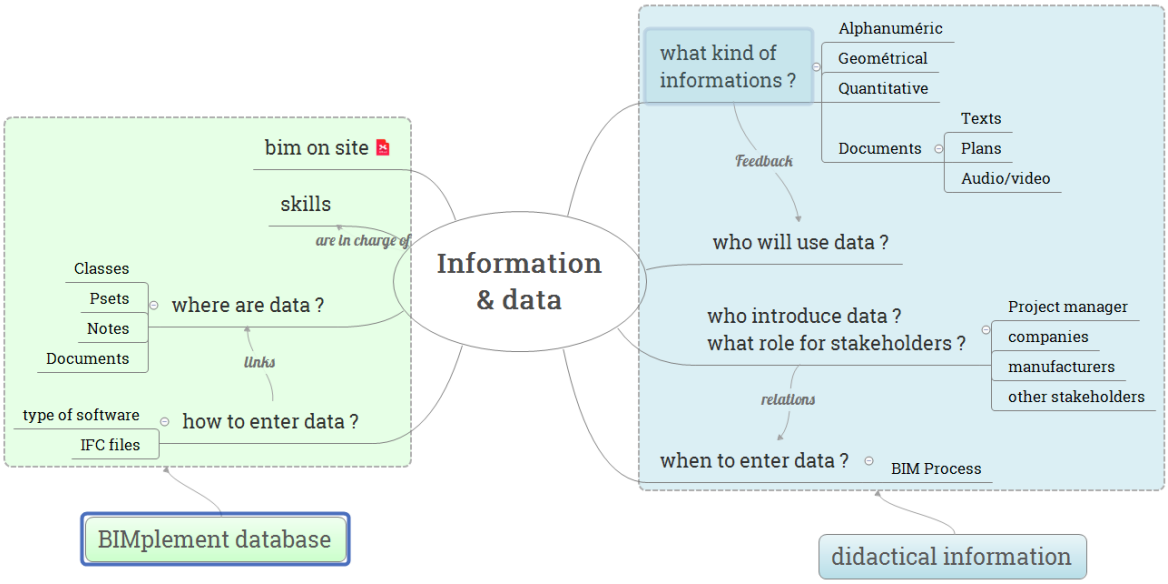


Illustration 6: data in a BIM model

8.1.1. What data have to be incorporated ?

A difference has to be made between :

- BIM object, which is a sole element (piece of pipe, ventilator …)
- Functional/technical system, that is a set of objects plugged together to answer a demand (ventilation system, that may be related to a specific zone or to the entire system)

8.1.1.1. what data, where are they ?

The following illustrations (see Ill.7&8)shows the different types of data for objects and systems. These data can be found in the model file tree (arborescence). However, the file tree organisation may be different depending on the viewers.

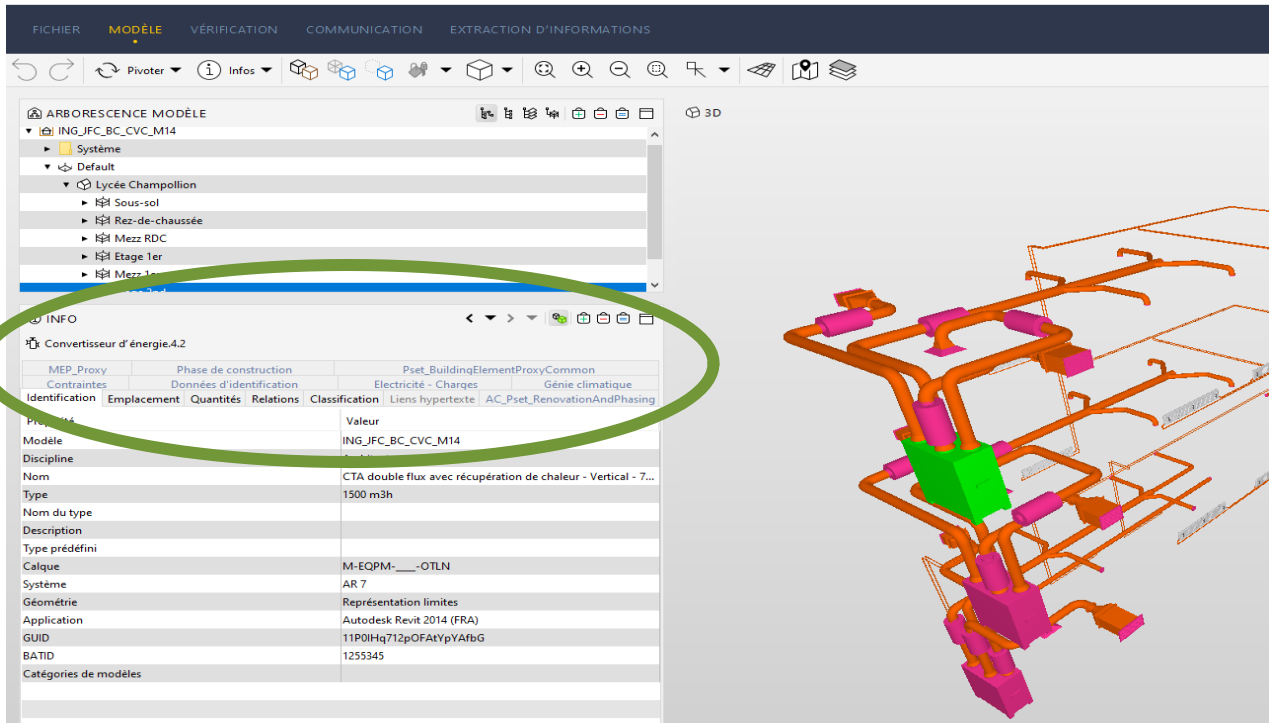


Illustration 7: data for a Balanced ventilation with heat recovery

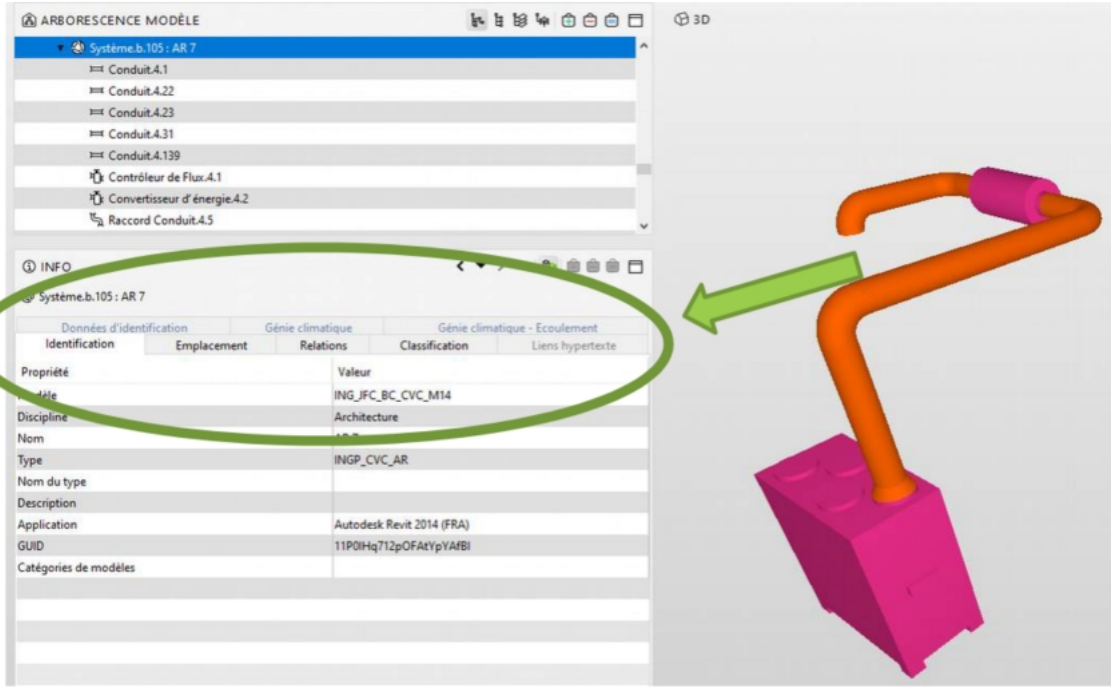


Illustration 8: Data for the ventilation system

8.1.1.2. what classification for these data ?

A classification system is an essential tool for organising information. Without an agreed, comprehensive system for organising construction information it will be impossible to ensure interoperability between different information systems, design tools, and facilities management tools, with data entered once and re-used several times through the process.
Classifying enables construction information to be organised, easily accessed, improved and shared. Building Information Modelling (BIM) needs structured information and a good classification is essential to this.

UK has defined his own classification : Uniclass2 (http://www.cpic.org.uk/uniclass2/). It provides a structured approach to classifying the building information by organising information based upon common characteristics. Uniclass2 extends beyond buildings to all aspects of the built environment. Uniclass2 groups information in tables and these tables can be viewed in a hierarchy of increasing detail as shown in Ill.9 .

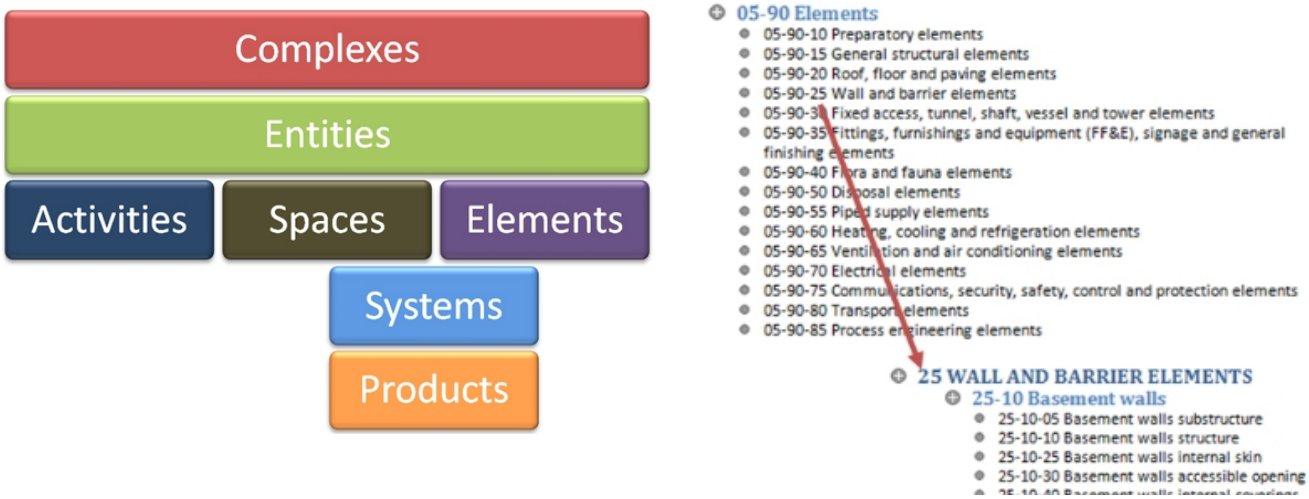


Illustration 9: Uniclass2, organisation and classification

Here , (see Ill.10), is another classification, UniFormat, proposed by Luxembourg

In France, there are no special national classification, and the most used one is the Uniformat classification

Classification Uniformat :

D				SERVICES
D	30			HVAC
D	30	60		Ventilation
D	30	60	10	Air soufflé
D	30	60	20	Air extrait
D	30	60	30	Air expulsé
D	30	60	40	Air neuf extérieur
D	30	60	60	Récupération d'energie Air-Air
D	30	60	70	Nettoyage d'air
D	30	60	90	Composants supplémentaires de ventilation

Objets IFC associés :

Bouches	*IfcAirTerminal*
Echangeur de chaleur	*IfcAirToAirHeatRecovery*
Filtres	*IfcFilter*
Diffuseur d'air	*IfcAirTerminalBox*
Ventilateur	*IfcFan*

Illustration 10: UniFormat object classification in Luxembourg

As reported in D3.1, the aim of the BIMplement QF is to be linked and coupled within the existing BIM processes. Therefore, the aim is not to produce additional new classification, but to use the existing ones (e.g. Uniclass2) and only add the type of information that is missing: educational metadata that is brought in from BIMplement QF ((see Ill.11).

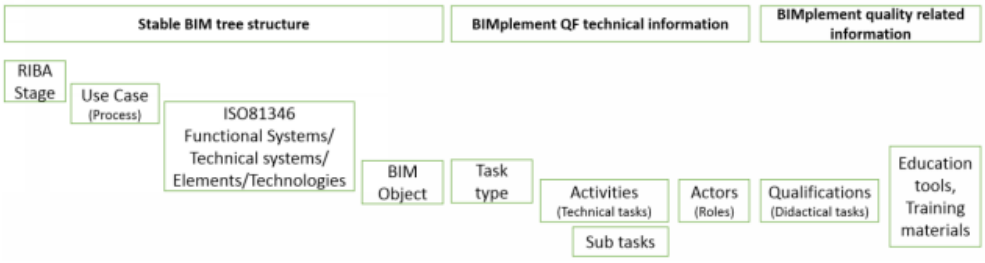


Illustration 11: BIMplement Qualification Framework

Coupling the BIMplement educational metadata within the existing BIM tools and models will depend on the experiments done per each pilot field lab and experimental site. As these experiments are dependent on the third parties agreements, needs, BIMplement objectives and their current skills capabilities, each experiment will be different (to be defined as part of the BIMplement implementation scripts).

Within the BIMplement project, a specific pilot field lab will be experimented with the BIMAXON platform. It is a classification that has been developed in Lithuania which proposes also an object numbering. (see Ill.12)

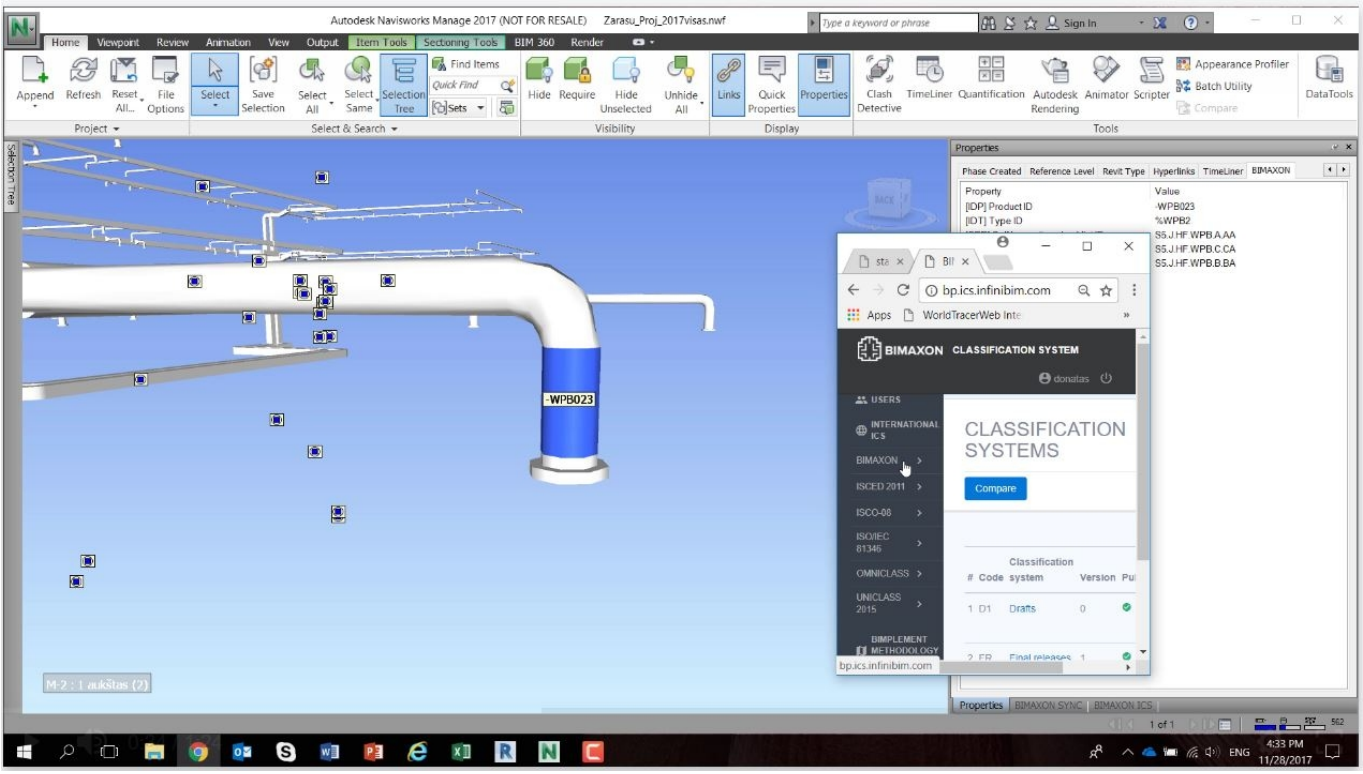


Illustration 12: object classification with BIMAXON

This BIMAXON classification platform is only one of the example on how we can link the BIMplement learning metadata within the BIM model (existing BIM processes).

Hence, existing classifications as well established BIM process structures (CEN/TC 442 Building Information Modelling (BIM)) and classifications (e.g. IEC 81346 and ISO TC 59/SC 13/WG 11: ISO 16757 Data structures for building services product catalogues) are to be used also in BIMplement to not invent something new, but to rather use what already exist and has proven to be useful.

8.1.1.3. in what space are theses objects attached to ?

A system or object can be linked to different IFC, such as space/building level that specifies where is this object (see Ill.13)… and also to IFC zone that specifies information on the required technical specifications.

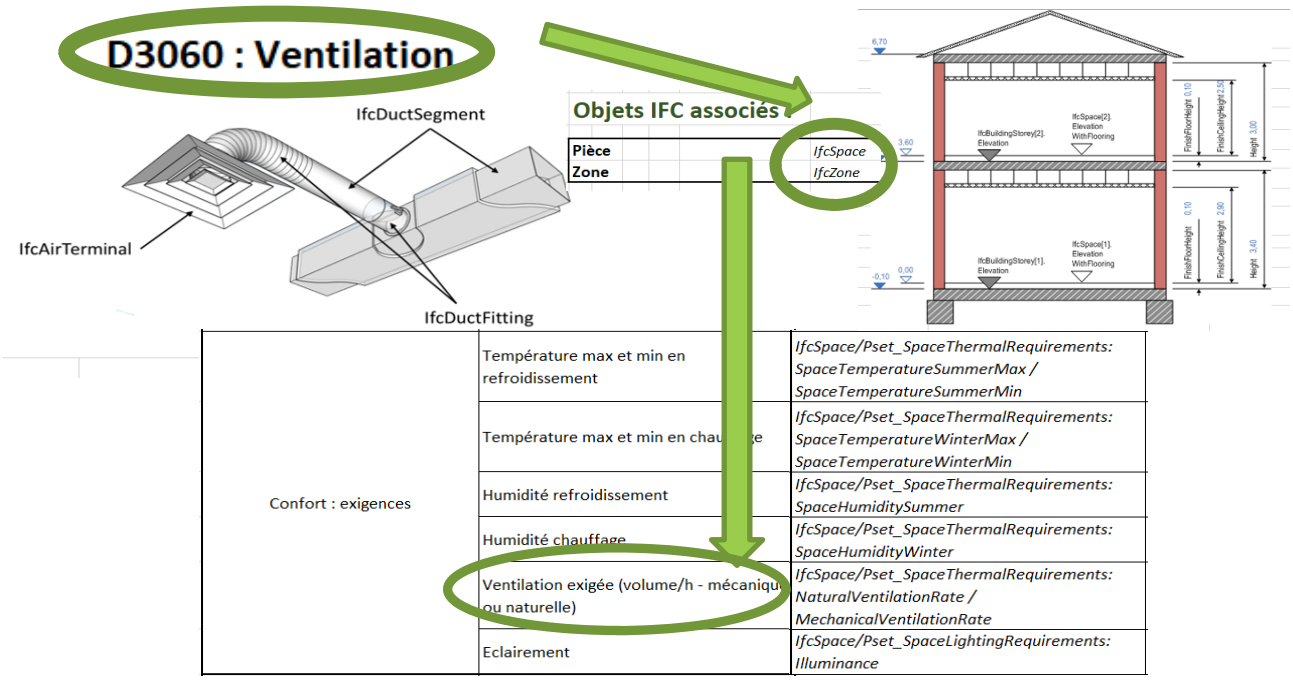


Illustration 13: IFC associated to a ventilation system

Hence, besides giving technical specifications to the objects – these objects may also 'hold' the BIMplement qualifications specifications (e.g. relevant content of BIMplement QF).

8.1.1.4. What compulsory data ?

Each project has its own objectives and issues. This means that each project manager has to specify what data has to be filled up for each object. These indications will be drafted in the "Simple BIM Execution Plan (BEP*)" (Protocole BIM, in France) by the project manager to the attention of building companies, to answer the client's needs (see Ill.14).

Définition des exigences d'échanges d'informations (EIR) -> Instructions

Uniformat Level					Omniclass Level						
1	2	3	4	5	Table	1	2	3	4	5	Termes anglais	Termes français (et liens vers les fiches)
D	30	60			21-	04	30	60	00	00	Ventilation	Ventilation

Elément à modéliser	Détail
Bouches	Position des bouches
	Longueur/largeur ou Diamètre des éléments
	Hauteur
Centrale de ventilation : position et dimensionnement du gabarit	Emplacement
	Longueur
	Largeur
	Hauteur
Centrale de ventilation : entrées et sorties	Position des prises et rejets d'air
	Longueur/largeur ou Diamètre des entrées et sorties
Modlisation des éléments spécifiques (supports, ...)	selon les cas
Modélisation représentative de l'élément placé	cf. objet fournisseur

Illustration 14: example of Simple BIM Execution Plan (BEP) for ventilation system*

This execution plan is based on the well known protocol 'BIM project execution planning guife' that was published by the Building SMART alliance : (https://vdcscorecard.stanford.edu/sites/default/files/BIM_Project%20Execution%20Planning%20Guide-v2.0.pdf) .

As explained in D3.1, in BIMplement, this plan has been simplified for the needs of the project (see above the schemes – definition of exchange of information).
For each project, the BIMplement objectives are identified per each project phase. To bring in the BIMplement QF, the identification of focus points is done (area of air-tightness and ventilation) where bringing in the content from the QF (reference to D3.1) helps identifying the needed qualifications to perform the tasks connected to the BIM objects or systems.

8.1.2. Who / for whom/ when enter these data ?

8.1.2.1. What type of IFC

Each information/data linked to an object has a specific IFC.
Here below (see Ill.15) is an example of a list of IFC and the corresponding data that has been declared compulsory information (type of information and details) filled for one French projects.

Elément à informer	Détail	Paramètres IFC (4) associés
Nommage / identification (selon convention, peut changer d'une phase à l'autre)	Nom de l'objet	*IfcRoot : Name*
	identifiant numérique de l'objet (tag)	*IfcElement : Tag*
Classification	Selon la classification choisie (ex. C1030)	*IfcClassification*
Statut	Distinguer NOUVEAU et EXISTANT (si nécessaire DEMOLI, TEMPORAIRE)	*IfcXXX/Pset_XXXCommon : Status*
Type (bouches)	Type de bouche (grille, grille avec valve, diffuseur, lucarne)	*IfcAirTerminalTypeEnum*
	Type de flux d'air (supply, exhaust, return)	*PsetAirTerminalCommon : Airflowtype*
Fixation des bouches	Positionnement : Sur mur (position haute), sur mur (position basse), sur plafond (périmère), sur plafond (intérieur), sur sol, autre...	*PsetAirTerminalCommon : Location*
	Mode de fixation : Fixé, Fixé dans l'alignement d'une surface, encastré	*PsetAirTerminalCommon : MountingType*
Débit d'air des bouches	Débit d'air volumique tel que conçu	*PsetAirTerminalCommon : AirFlowRate*
	Débit d'air volumique mesuré	*Pset_AirTerminalPHistory : AirFlowRate*
Température d'air soufflé mesurée	en chauffage	*Pset_AirTerminalPHistory : SupplyAirTemperatureHeating*
	en refroidissement	*Pset_AirTerminalPHistory : SupplyAirTemperatureCooling*
Type (échangeurs)	Type de fonctionnement (à co-courants, à contre-courants, à courants croisés, échangeur rotatif...)	*IfcAirToAirHeatRecoveryTypeEnum*
débit CTA (Centrale de Traitement d'Air)	débit d'air de la CTA	*Pset_AirTerminalBoxTypeCommon : NominalAirFlowRate*
Garantie	Date de fin de garantie	*Pset_Warranty : WarrantyEndDate*
Condition	Date de l'évaluation	*Pset_Condition : AssessmentDate*
	Condition évaluée	*Pset_Condition : AssessmentCondition*

Illustration 15: list of ventilation IFC

8.1.2.2. At which project phase are they integrated ?

Depending on the phase of the project, the level of detail required for the IfcObject will be different, mainly because in certain phase, one cannot have these details.
The LOD (Level Of Detail) parameter varies from 1 to 5, depending on the needs of the project manager and Facility manager. Illustration 16 shows the level of detail for a ventilation system for a ventilation network. This table is a part of the BEP.

NIVEAU DE DOCUMENTATION*						
Type de document	**Détail**	GID XX1	GID XX2	GID XX3	GID XX4	GID XX5
Schéma	Dessin unifilaire du réseau		X			
	Schéma d'emprise	X	X			
Note descriptive	Type d'élément et équipements	X	X	X		
	préconisations techniques	X	X	X		
Fiche technique	De chaque équipement				X	X
Protocole de mesure	De chaque équipement				X	X
Notice	Notice de montage				X	X
	Notice de maintenance				X	X
Rapport	Carnet d'entretien				X	X
Image représentative	de l'objet choisi puis en place		selon les besoins	selon les besoins	Fiche technique	Fiche technique

Illustration 16: required level of details for attached technical documents

8.1.2.3. technical document and BIMplement educational material attached inside the BIM model

To provide knowledge sources, educational material (also e-learning materials), installation guidelines inside the BIM models, technical documents, comments on the project … the relevant documents can be directly attached to any objects. Usually, they are pdf documents or can even be videos showing the installation procedures etc.
They appear in the BIM model as small clickable icons (see Ill.17).

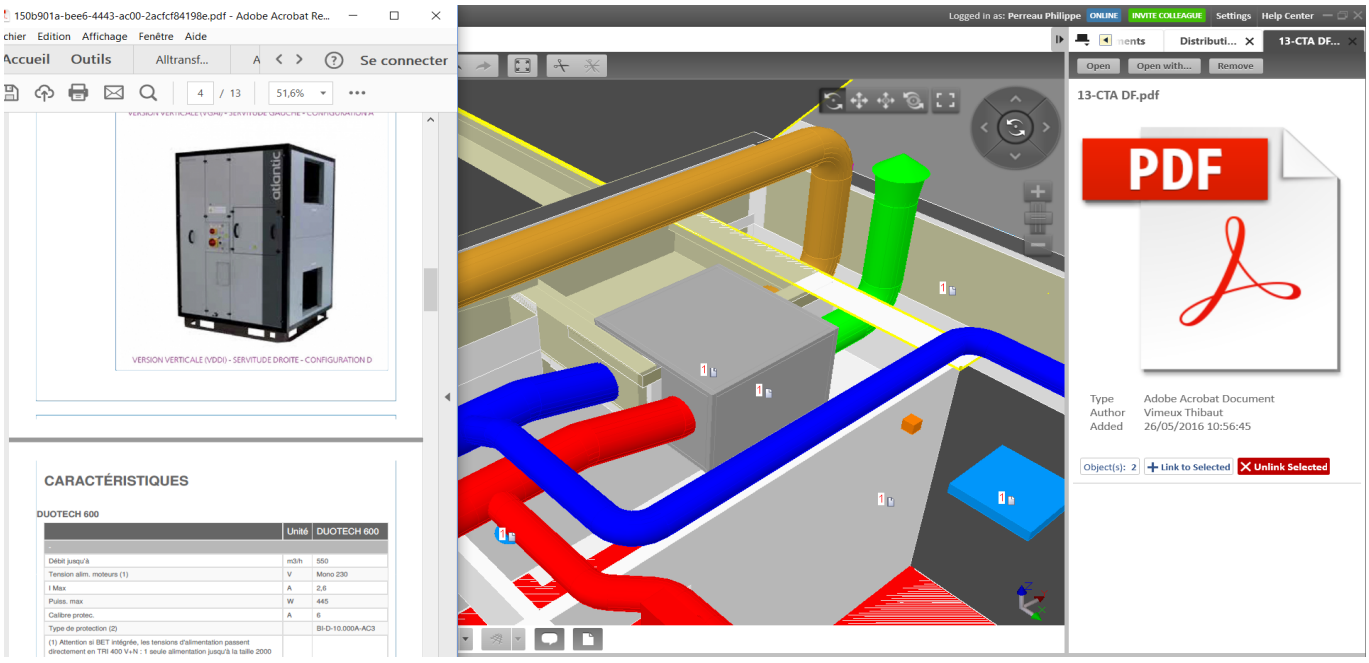


Illustration 17: attached document to a ventilation engine

8.1.2.4. Objects from e-catalog

Instead of entering each data, building companies who will order the corresponding components can enter the real object from an e-catalogue (see Ill.18).
Many manufacturing companies made available e-catalogue for their own products, including all IFC data that can be introduce in the model (for instance execution model in a call for bid, or as-built model for commissioning or facility management).

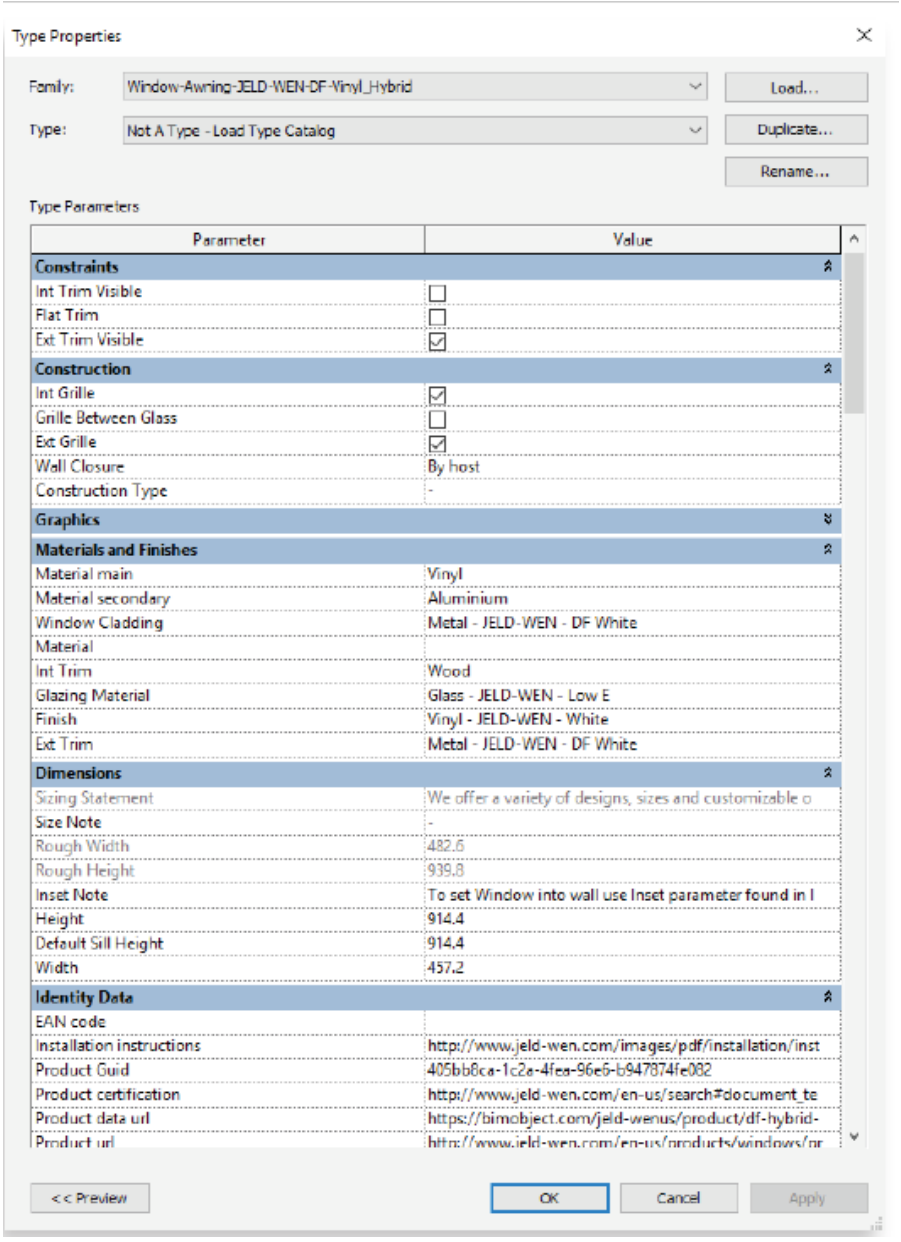


Illustration 18: object tab, including data and technical documents (ID data)

When using a classification, the numbering appears in the object details.

8.1.2.5. How to frame the data to be integrated in BIM models

Construction Operations Building Information Exchange (COBie) is an international standard relating to managed asset information including space and equipment. In UK, the use of “COBIE” classification for object information is compulsory for all projects.

Illustration 19 shows an example of an excel export of IFC COBIE files, that give the compulsory level of information per object.

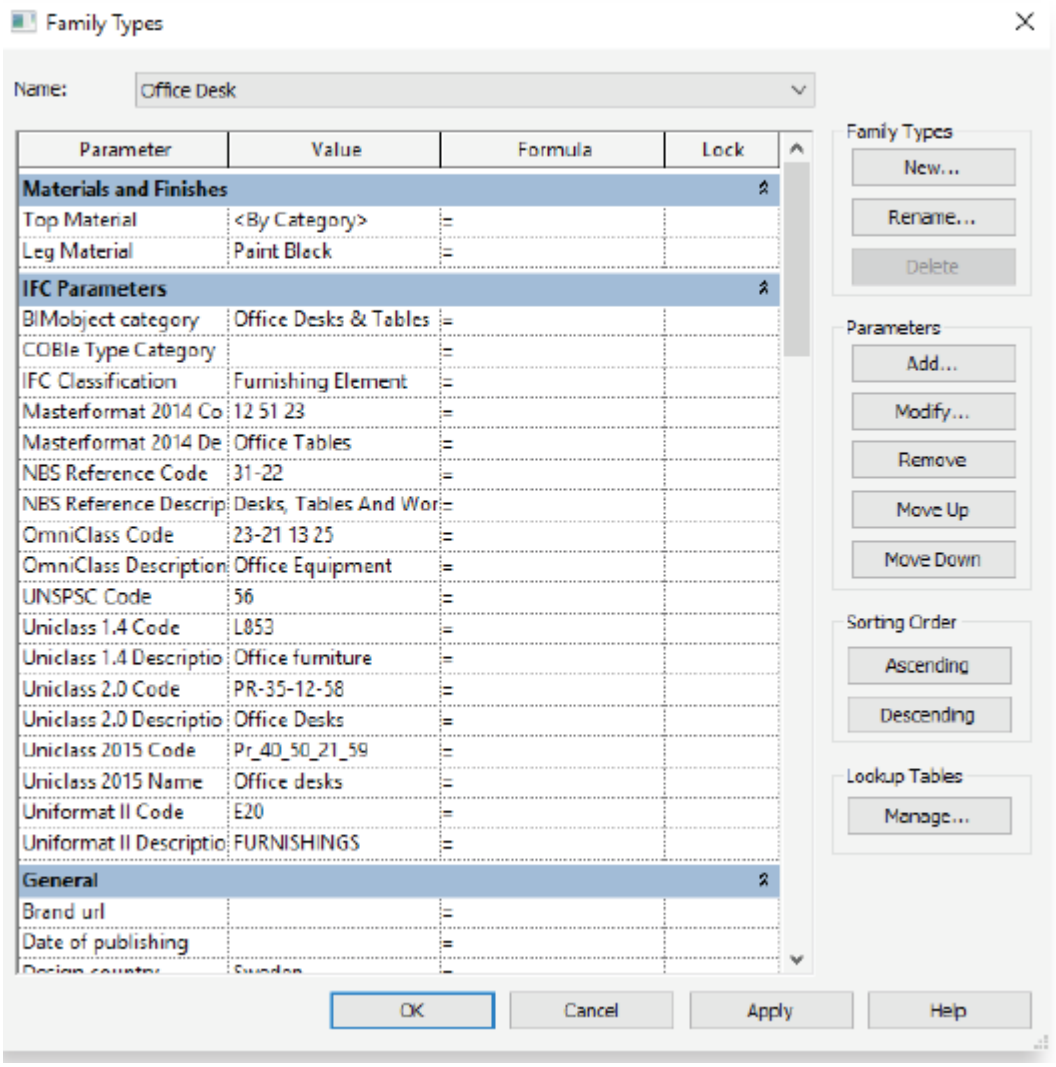


Illustration 19: COBIE export of ifc Objects

Outside UK, there is no common rules. There exist requests from facility managers, but there is yet no general agreement in EU.
Up to now, in France, there is still no general rules to be implemented. Investigations are on with BIMplement partners to establish local policies in terms of classification.

8.1.2.6. who enters/uses this information ?

Data can be introduced by different persons depending on the project phase and the required LOD (Level of Definition).
What skills are needed to incorporate / read these data ?
What knowledge is required to get these skills ?

8.1.2.7. Insert BIMplement QF data

In terms of skills needed for implementation of an object, the BIMplement QF can be linked directly in the BIM object database. It can even be already inserted in the BIM libraries by manufacturers.

Furthermore, along the project phases, relevant stakeholders and white collars can add relevant educational information to the building details, building plans, facility management, ...

8.1.2.8. Insert technical information

For instance, an as-built model may include data that will be useful (or not) for a facility manager. When a project asks for a specific use of the BIM model by a facility manager, then :

- a list of the requested data should be available, right from the start (see III.20)
- specification should indicate who will enter these data

Liste des attributs «BIM pour le FM» pour l'équipement					
Designation de l'équipement :			Niveau de modélisation LOD :		
Photo/Illustration	Catégorie de l'équipement :		Codification Uniformat II :		
	Description :		Documents à associer à l'équipement :		
Catégorie de l'attribut (Type d'information)	Attribut requis (Description)	Unité (M, Pa, L/Min)	Format (Texte, numérique, mixte)	Source de l'information	Destinataire de l'information (BIM, GMAO, GTB)
Information de localisation	Nom du bâtiment				
Information de localisation	Numéro de l'étage				
Information de localisation	Numéro ou nom du local				
Information de localisation	Numéro de bureau				
Information fabricant	Nom du fabricant				
Information fabricant	Coordonnées				
Information fabricant	Référence équipement fabricant				
Information fabricant	Numéro de série				
Information fabricant	Année de fabrication				
Information fabricant	Code-barres/QR fabricant				
Facilities/Asset Management	Code d'identification FM				
Facilities/Asset Management	Code-barres/QR FM				
Facilities/Asset Management	Coûts de remplacement				
Facilities/Asset Management	Coûts d'installation				
Facilities/Asset Management	Coûts de l'équipement				
Facilities/Asset Management	Désignation de l'équipement				
Facilities/Asset Management	Type de réseaux				
Facilities/Asset Management	Référence du manuel équipement				
Facilities/Asset Management	Type de garantie				
Facilities/Asset Management	Responsable de la garantie				
Facilities/Asset Management	Date de démarrage de la garantie				
Facilities/Asset Management	Date de fin de garantie				
Facilities/Asset Management	Liste des pièces détachées				
Facilities/Asset Management	Fournisseur des pièces détachées				
Facilities/Asset Management	Instructions de maintenance				
Facilities/Asset Management	Type de contrôle				
Facilities/Asset Management	Dernières valeurs relevées				
Facilities/Asset Management	Mise en sécurité				
Informations de planning	Date de mise en service				
Informations de planning	Périodicité de contrôle				
Informations de planning	Date du dernier contrôle				
Spécifications	Dimensions				
Spécifications	Poids				
Spécifications	Type de connectiques électriques				
Spécifications	Dimension des connectiques électriques				
Spécifications	Type de connectiques plomberie				
Spécifications	Dimension des connectiques plomberie				
Spécifications	Type de connectiques ventilation				
Spécifications	Dimension des connectiques ventilation				
Spécifications	Couleurs/finition				
Spécifications	Capacité				
Spécifications	Niveau sonore				
Spécifications énergétiques	Type d'alimentation				
Spécifications énergétiques	Consommation				
Spécifications énergétiques	Températures de fonctionnement				
Spécifications énergétiques	Débit d'air				
Spécifications énergétiques	Débit d'eau				
Spécifications énergétiques	Taux d'humidité				
Spécifications énergétiques	Pression de fonctionnement				
Spécifications énergétiques	Consommation eau				
Spécifications énergétiques	Consommation gaz				
Spécifications énergétiques	Consommation électrique				
Spécifications énergétiques	Valeurs relevées à l'installation				

Illustration 20: table that indicates a list of data that can be required for Facility Management

8.2. How is the "ventilation" batch incorporated in the BIM process steps ?

This step means to identify all elements in the project related to ventilation.

8.2.1. *What are the facility manager requirements ?*

The facility manager requirements are often related to the way he will deal with his building. He can use different tools such as :

- facility management software (see Ill.21)
- excel table with a nomenclature or a classification
- possible connexion with the BEMS software

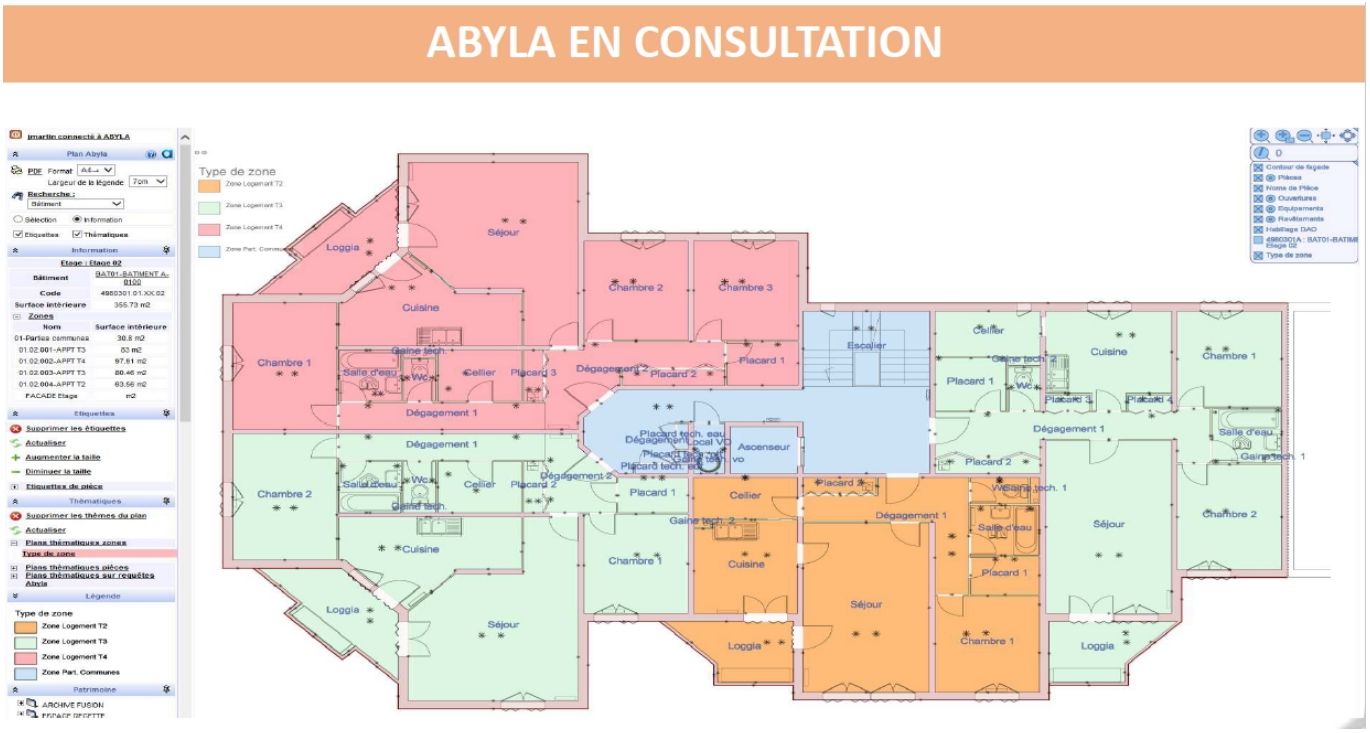


Illustration 21: example of the "ABYLA" facility management software

When using a Facility management software, such as ABYLA, there might exist a function that controls the BIM model data (ABYLA checker)(see Ill.22, 23 &24)

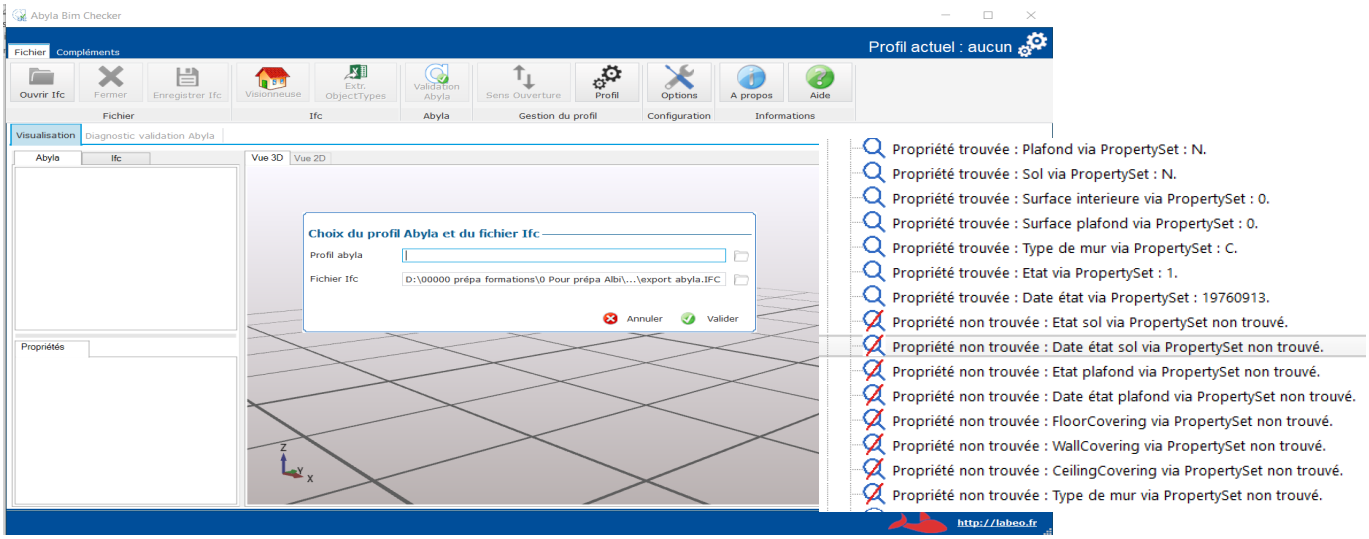


Illustration 22: ABYLA Checker verifies data

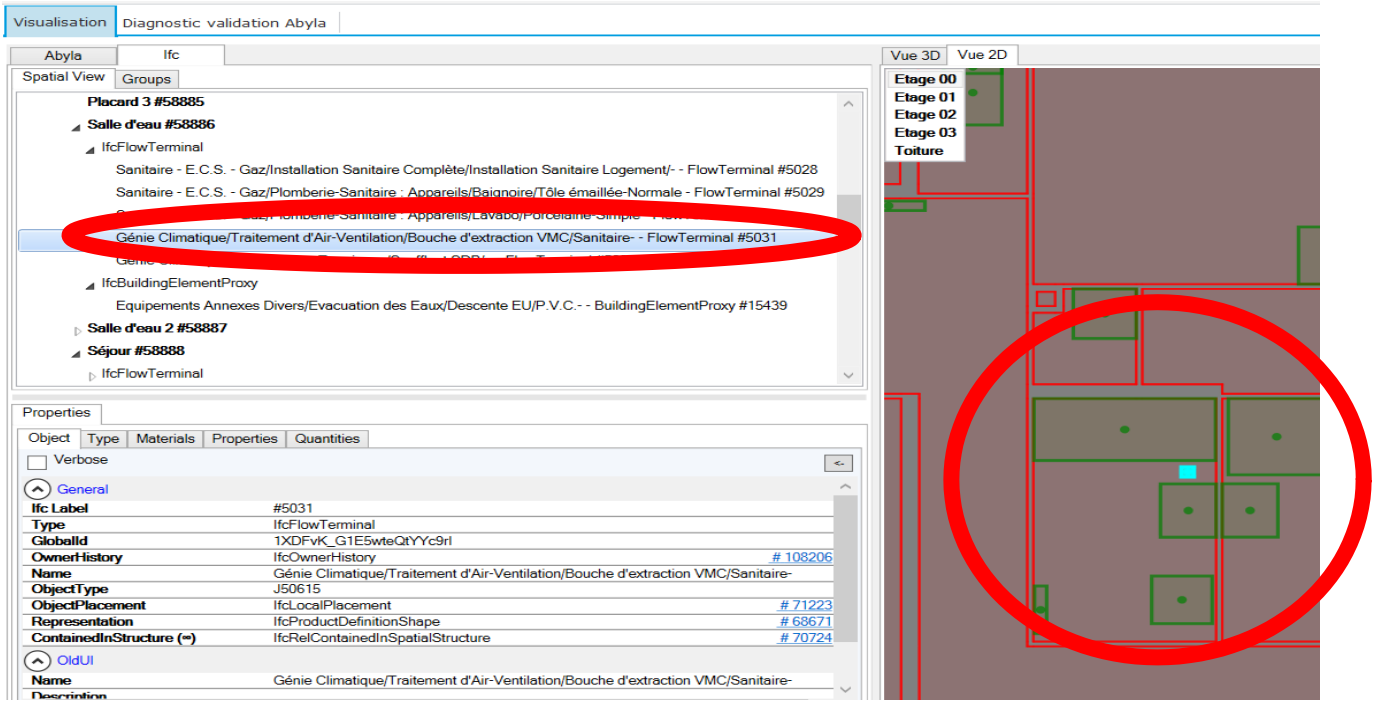


Illustration 23: ABYLA Checker shows the position of an object

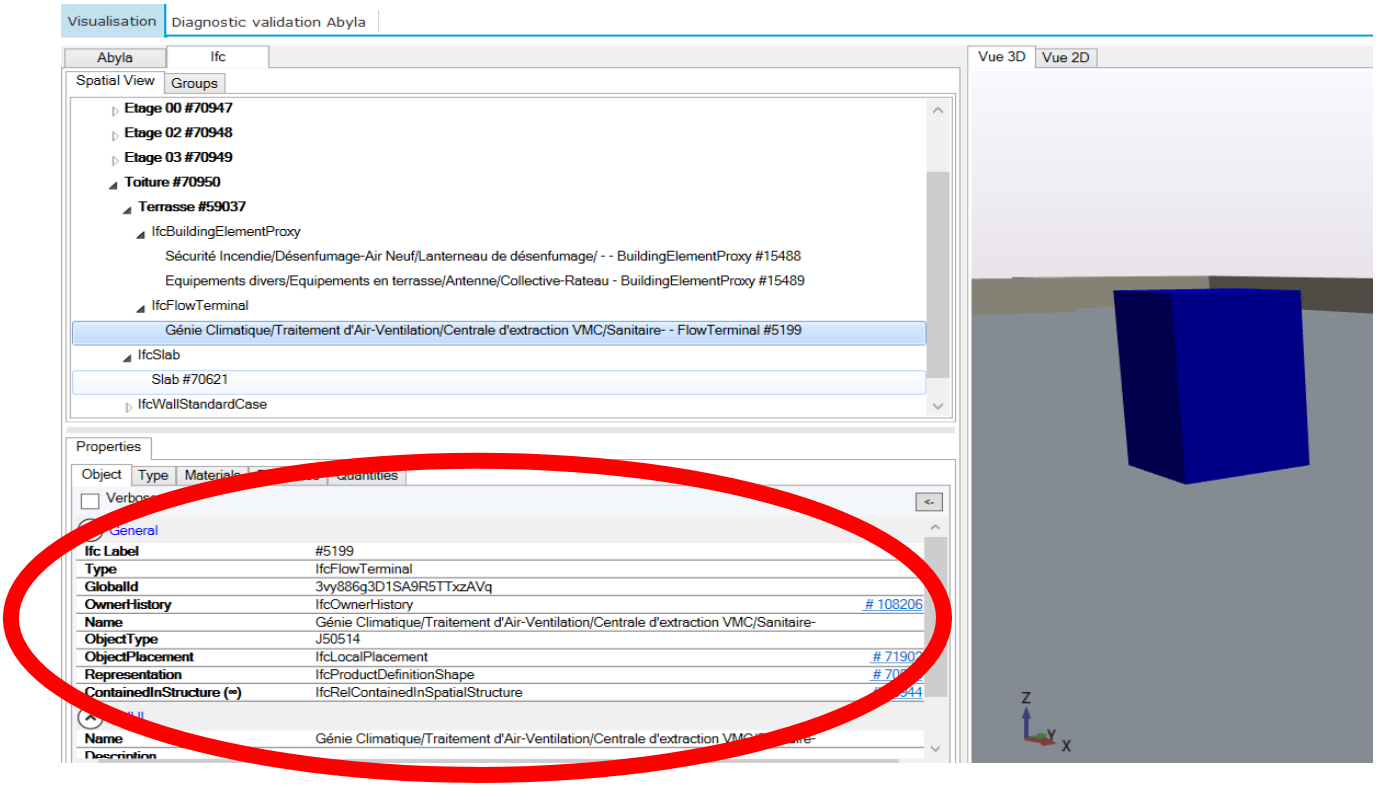


Illustration 24: ABYLA Checker shows the data details

The building management may also be realized with a BEMS software (see Ill.25)

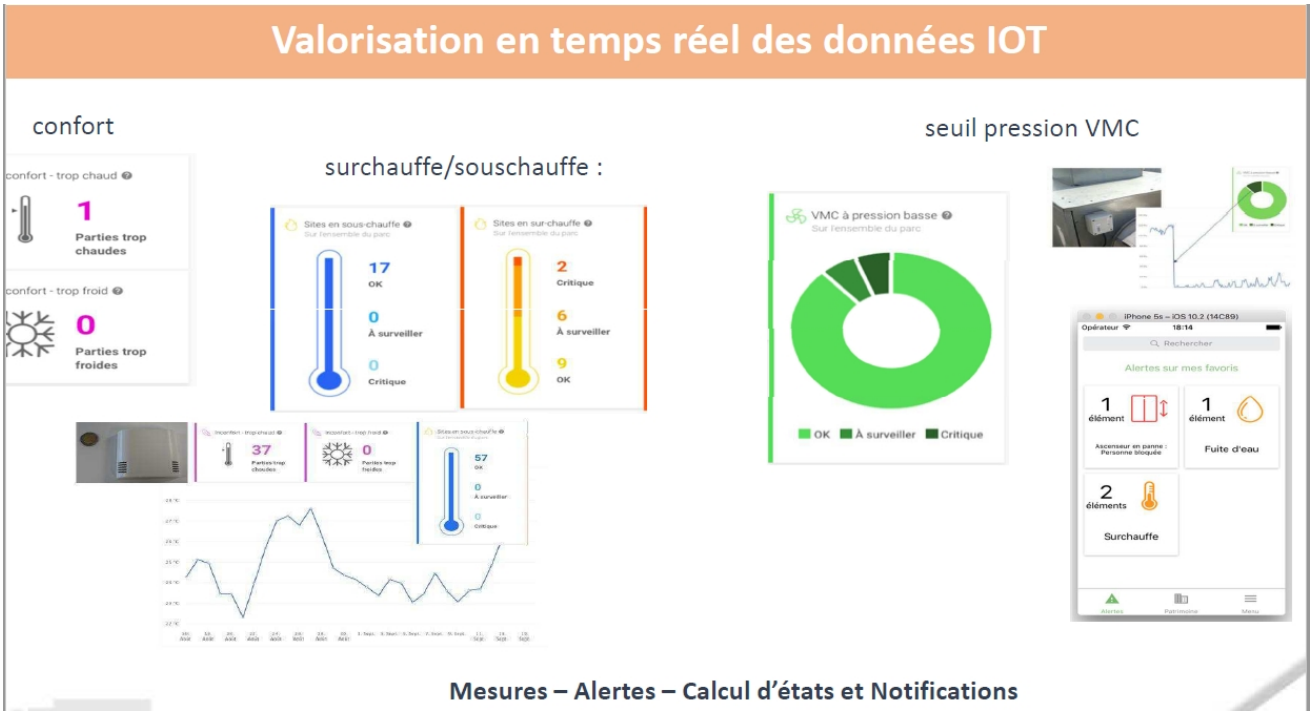


Illustration 25: Follow-up of a building with a BEMS software

8.2.2. What are the client's objectives

The client's BIM requirement (see Ill.26)are drafted in a contractual specification document. It specifies the list of IFC-objects to be filled in, and the type of data to be given.

Autres équipements terminaux	La classe la plus adaptée à la fonction de l'équipement Exemple : *IfcFlowTerminal pour les sanitaires).* A défaut, *IfcBuildingElementProxy*	Les équipements terminaux suivants sont décrits comme des objets afin qu'il soit possible de connaître leur localisation et de les dénombrer selon leur type : • équipements sanitaires, • équipements de cuisine, • équipements de production de chaleur (chaudière, générateur, radiateurs,...) • équipements de production d'eau chaude sanitaire (chauffe-eau, chauffe-bains à gaz,...) • équipements de ventilation (VMC, VMC gaz,...) • équipements de sécurité incendie (système de désenfumage, bloc de secours,...) • armoires électriques,
Conduits, canalisations et gaines	*IfcFlowSegment, IfcFlowFitting*	Les conduits de fumée et colonnes sèches sont décrits comme des objets. Les canalisations et gaines sont décrits comme des objets ou, à défaut, sont seulement représentées dans des plans.
Gaines techniques	*IfcSpace*	

Appareils de ventilation	Déstratificateur	IfcFanType				S	Local	Dénomination Code Marque-modèle	S	Local	Dénomination Code Marque-modèle ref : Fiche produit	DEST
	Ventilateur	IfcFanType				S	Local	Dénomination Code Marque-modèle	S	Local	Dénomination Code Marque-modèle ref : Fiche produit	VENT
	Thermostats de régulation	ifcBuildingElementProxy				S	Local	Dénomination Code Marque-modèle	S	Local	Dénomination Code Marque-modèle ref : Fiche produit	TERM
	Ventilo-convecteur et caissons	IfcSpaceHeaterType				E	Local	Dénomination Code Marque-modèle	E	Local	Dénomination Code Marque-modèle ref : Fiche produit	VTCN

Illustration 26: extracts from a client's BIM specification regarding ventilation objects

As described in D3.1, this contractual specification document can furthermore include definition of BIMplement related objectives which will define the requirements of the BIMplement QF (choice on implementation area, focus points where it is needed to improve the quality by up-skilling and educating carefully the involved professions).

The client's BIM specification may also indicate different requirements depending of the project phase and LOD (see Ill.27).

D30 - HVAC							
Baseline	Part 1 - Attribute Description	Part 2 - LOD Profile					
Additional							
Attribute	Commentary	100	200	300	350	400	
Global Attributes							
Component ID	Project assigned number for components (e.g. tag number)		x	x	x	x	
Condition Status	Status of the element, predominately used in renovation or retrofitting projects		x	x	x	x	
Room Number	Room number where component **to be**/is installed		x	x	x	x	
Room Name	Room name where component **to be**/is installed			x	x	x	
Story Number	Floor or level room is located		x	x	x	x	
Manufacturer Name	The organization that manufactured and/or assembled the item.				x	x	
Product Name	The descriptive model name of the product model (or product line) as assigned by the manufacturer of the manufactured				x	x	
Model Designation	The model number or designator of the product model (or product line) as assigned by the manufacturer of the				x	x	
Component characteristics	**Defines properties of individual instances of manufactured products that may be given by the manufacturer.**						
Acquisition Date	The date that the manufactured item was purchased.				x		
Assembly Place	Enumeration defining where the assembly is intended to take place, either in a factory, other offsite location or on the				x		
Bar Code	The identity of the bar code given to an occurrence of the product.				x		
Batch Reference	The identity of the batch reference from which an occurrence of a product is taken.				x		
Production Year	The year of production of the manufactured item.				x		
Serial Number	The serial number assigned to an occurrence of a product.				x		
Design Performance	design performance parameters as defined in the BIMXP to be associated with model elements as non-graphic information.			x	x	x	
Target LOD							
Current LOD							
Service Life	**Captures the period of time that an artifact will last.**						

... | B – Ext. Doors | B – Cladding | B – Roof | B – Ext. Wall | C - Int. Windows | C - Int. Doors | C - Partitions | C - Raised Floor | C - Susp. Clg. | D20 - Plumbing 22 | D30 - HVAC | D- Air Distribu

Illustration 27: required data sorted with LOD level

8.2.3. what are the control office requirements ?

The overall and general explanation of the quality control aspects and systematic quality control method inside any construction project, along all the project phases, has already been explained in the D3.3 (BIMplement Model nZEB Quality and BIM Skills Matrix). Hence, in practice the aim of he client's control office aims at assuring the client that the project will be consistent with his specifications, along with the project design phases (see Ill.28).

Maquettes	Granularité	Concours	APS	APD	PRO	EXE DOE	Informations spécifiques au projet à intégrer
MEP (GC, CFO, CFA, CVC, plomberie, incendie, cuisiniste)	• Réseaux principaux (Canalisations / Conduits / Gaines / Sprinklers)			●	●	●	• Localisation, dimensionnement, modélisation et identification • Typologie • Quantité de base (Diamètre et longueur) • Matériaux
	• Ponts singuliers (Coudes, raccords,...)				●	●	• Localisation, dimensionnement, modélisation et identification • Typologie • Quantité de base (Diamètre) • Matériaux
	• Equipements principaux (Yc modélisation systèmes élévateurs)				●	●	• Localisation, dimensionnement, modélisation et identification • Encombrement (largeur, hauteur, longueur)

Illustration 28: list of a control office requirement depending on the project different phases

In addition, a control office (ex: SOCOTEC) may require data about risk management, ans ask for specific properties (Pset)Pset_Risk to be given. For instance :

- Nature of risk (NatureOfRisk)
- sub-category level 1 (SubNatureOfRisk1)
- sub-category level 2 (SubNatureOfRisk2)
- level of risk (AssessmentOfRisk)
- Origin of risk (RiskCause)
- Type of risk (TypeOfRisk)
- Preventive measures (PreventiveMeasure)
- Impacts on surroundings (AffectsSurroundings)
- Risk classification (RiskRating)
- Possibles consequences (RiskConsequence)
- Responsable (RiskOwner)

8.2.4. what decisions have been taken by the project manager or architect ?

The architect's or Project manager's decision may be about :

- type of ventilation system
- location of technical spaces, of technical ducts … (see Ill.30)
- height of false ceilings (see Ill.29)
- project zoning ….

For each decision, there will be impacts on the models and data to be entered.

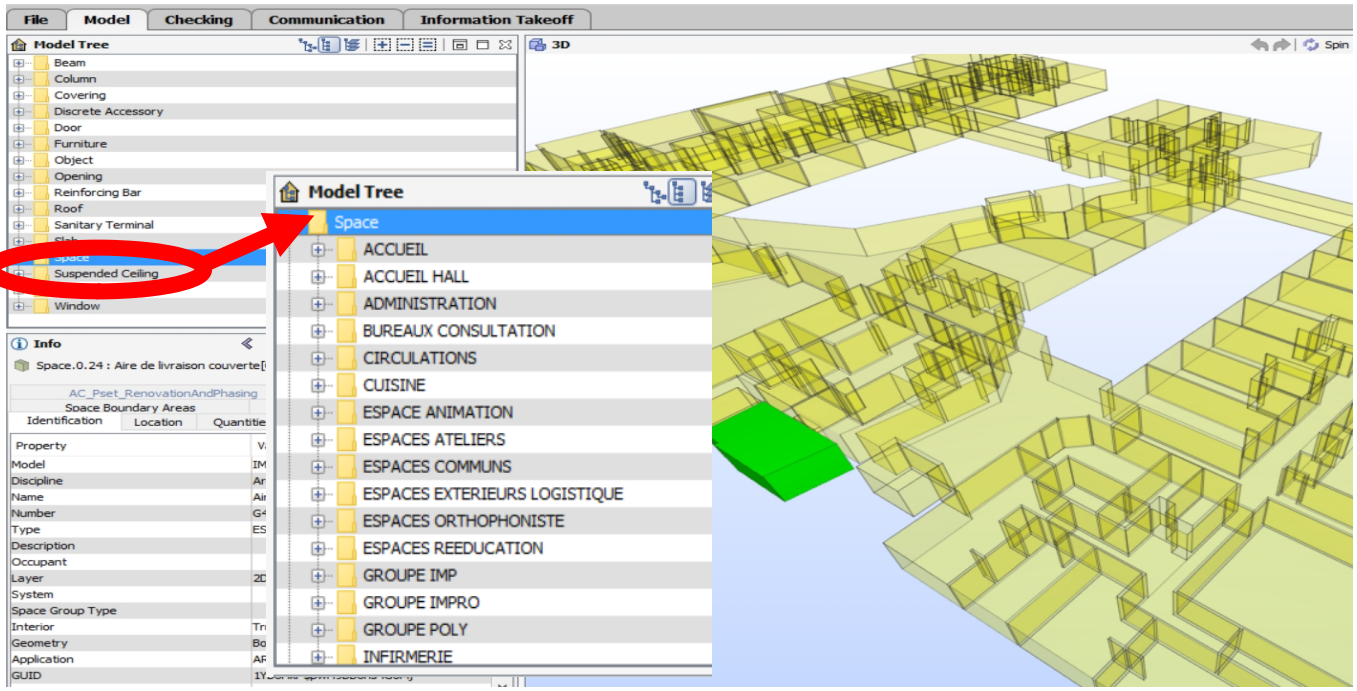


Illustration 29: location of a suspended ceiling in a space element

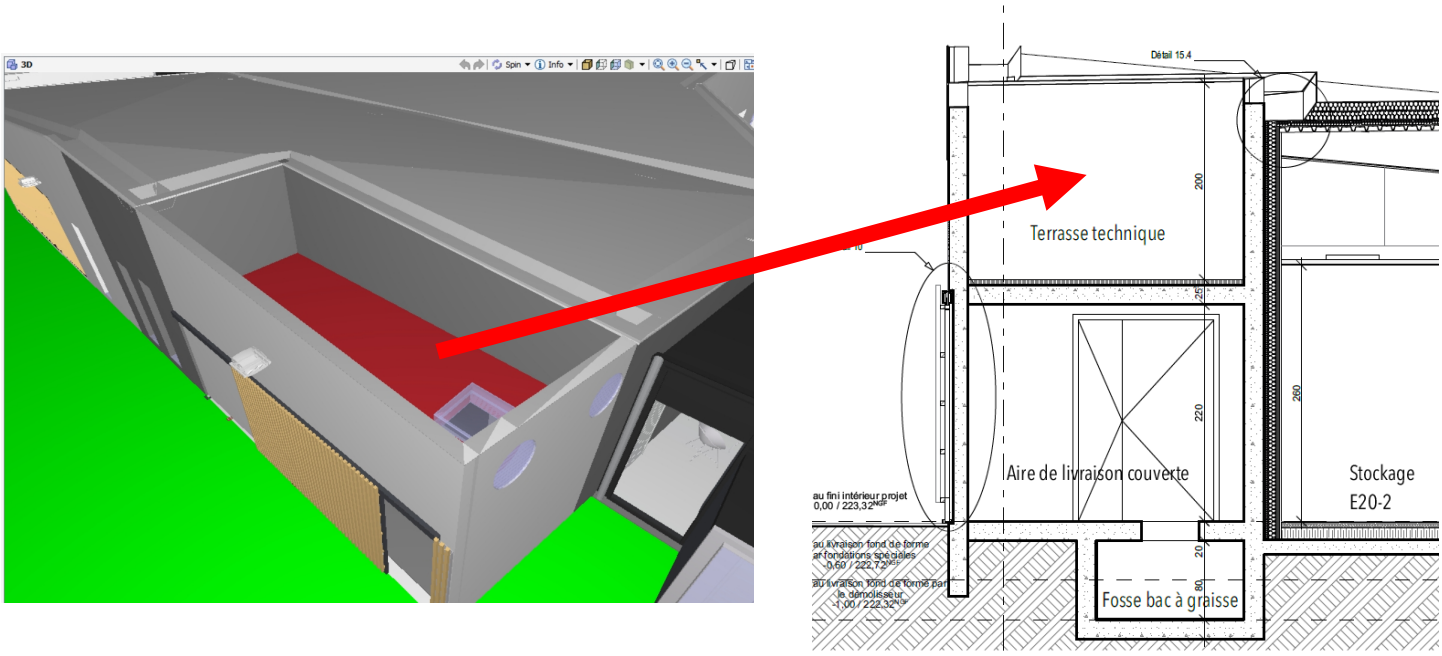


Illustration 30: location of a technical space

Illustration 31 displays a room with false ceiling. The building company has to check if there will be space enough for the ventilation (and other networks)

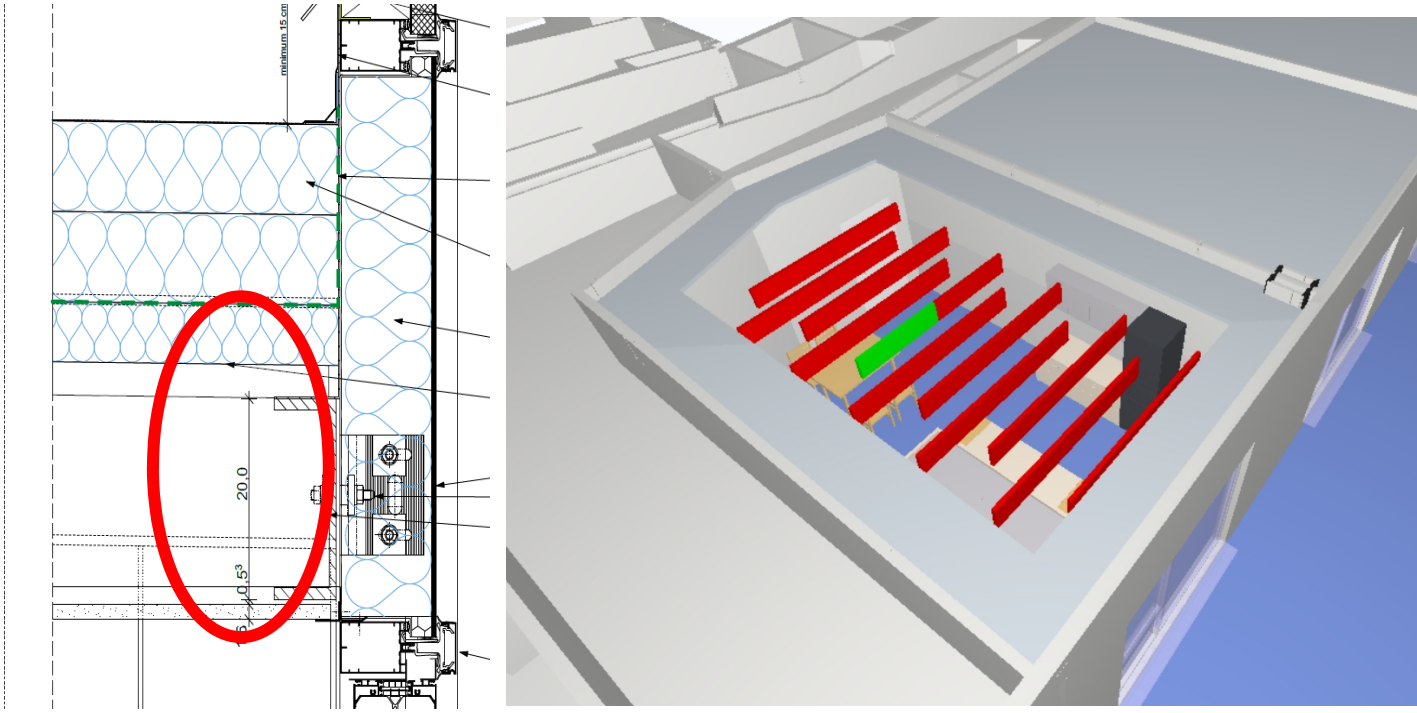


Illustration 31: check the free space left over the false ceiling

8.2.5. what has been laid down by the project manager MEP design office ?

One of the main important problem encountered by building companies when answering a call for bid, is the lack of information within the BIM model.

This fact obliges the companies to look for information in all the different and available documents included in the call for bid, with the risk of errors between these documents. This is the

reason why it is important to explain and convince project managers and their design office that a BI model is not only for their use of the model, but also for other stakeholders needs. This is one aspect of the necessary cross trade collaboration.

For instance, in Illustration 32, the ventilation device (CTA) is not completed in its field.

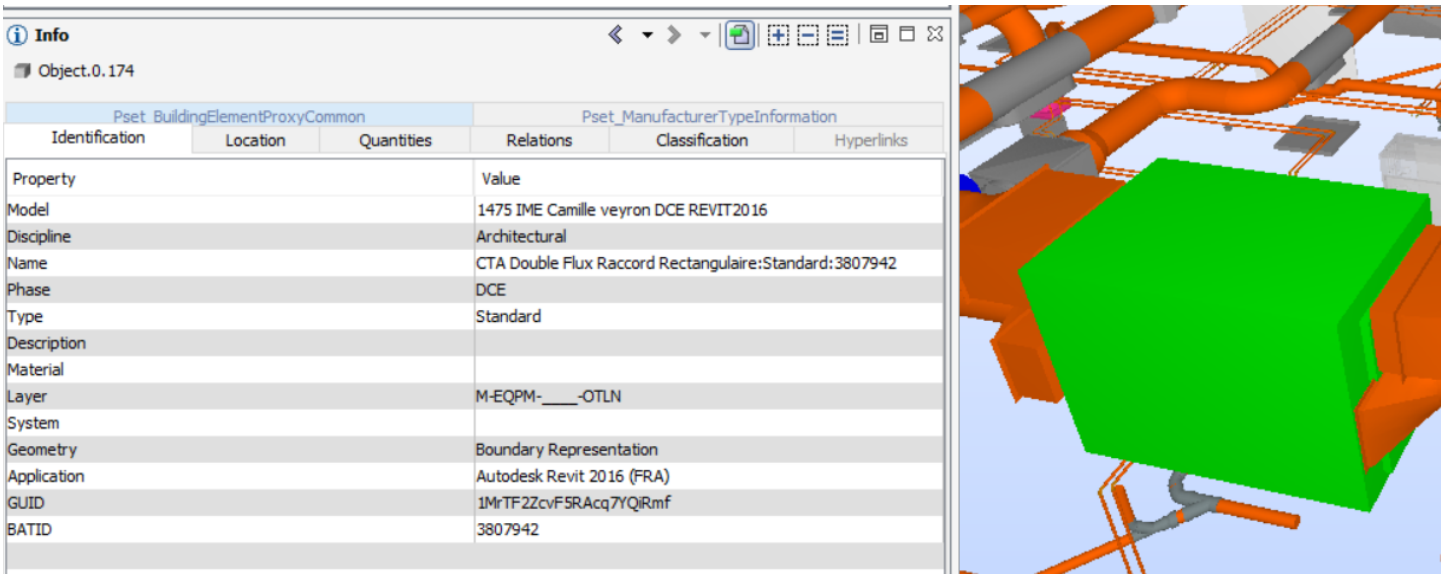


Illustration 32: no information for the ventilation device (description, material)

In the following case, the building company has to understand that the technical space is placed outside the building (no door or communication)(see Ill.33). It will have to assess the consequences of such a choice.

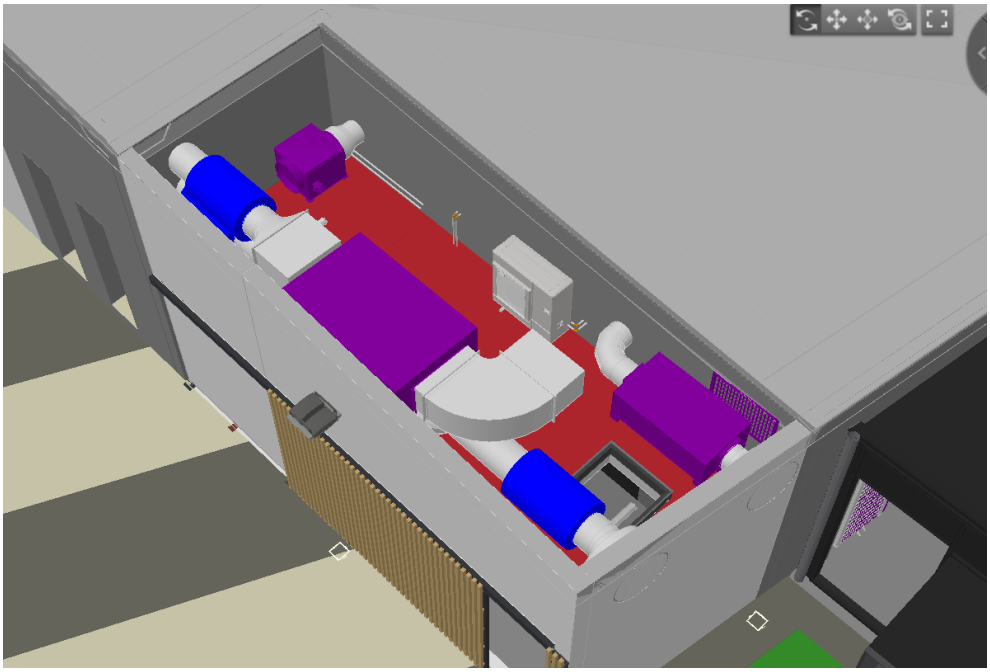


Illustration 33: location of a technical space

8.2.6. *what answers are expected from the building companies, and how ?*

Once the project has been distributed between several building companies, the BIM Execution Plan (BEP),also called BIM protocol, will specify what is expected from each company in charge of a batch : either realize his own technical BIM model, or use a viewer to check what the project manager has designed.

In this here below example (see Ill.34), the wood structure requires a specific trade BIM model, and the MEP company has only to use a viewer.

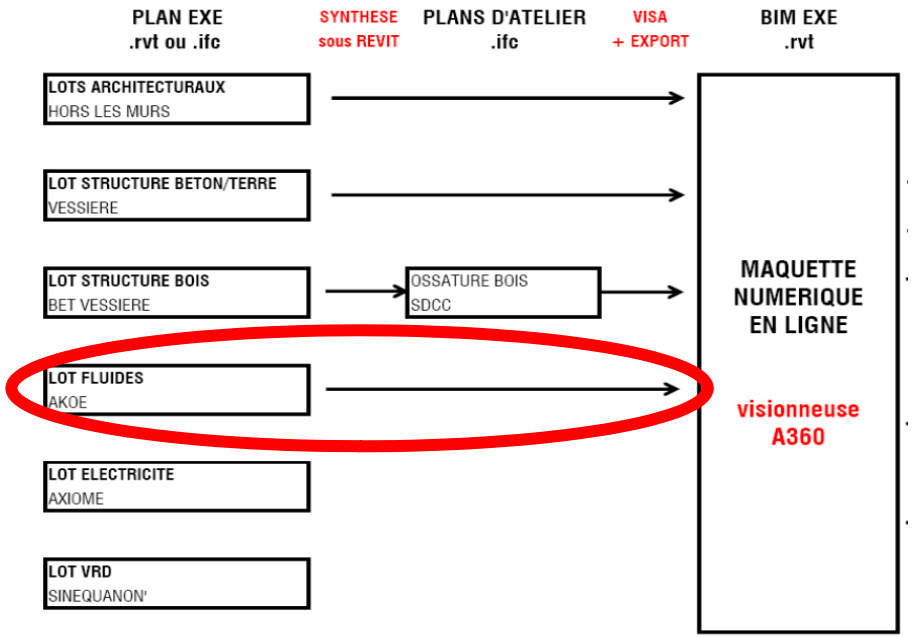


Illustration 34: on site simple BEP

In this second example (see Ill.35), the BEP is more complex.

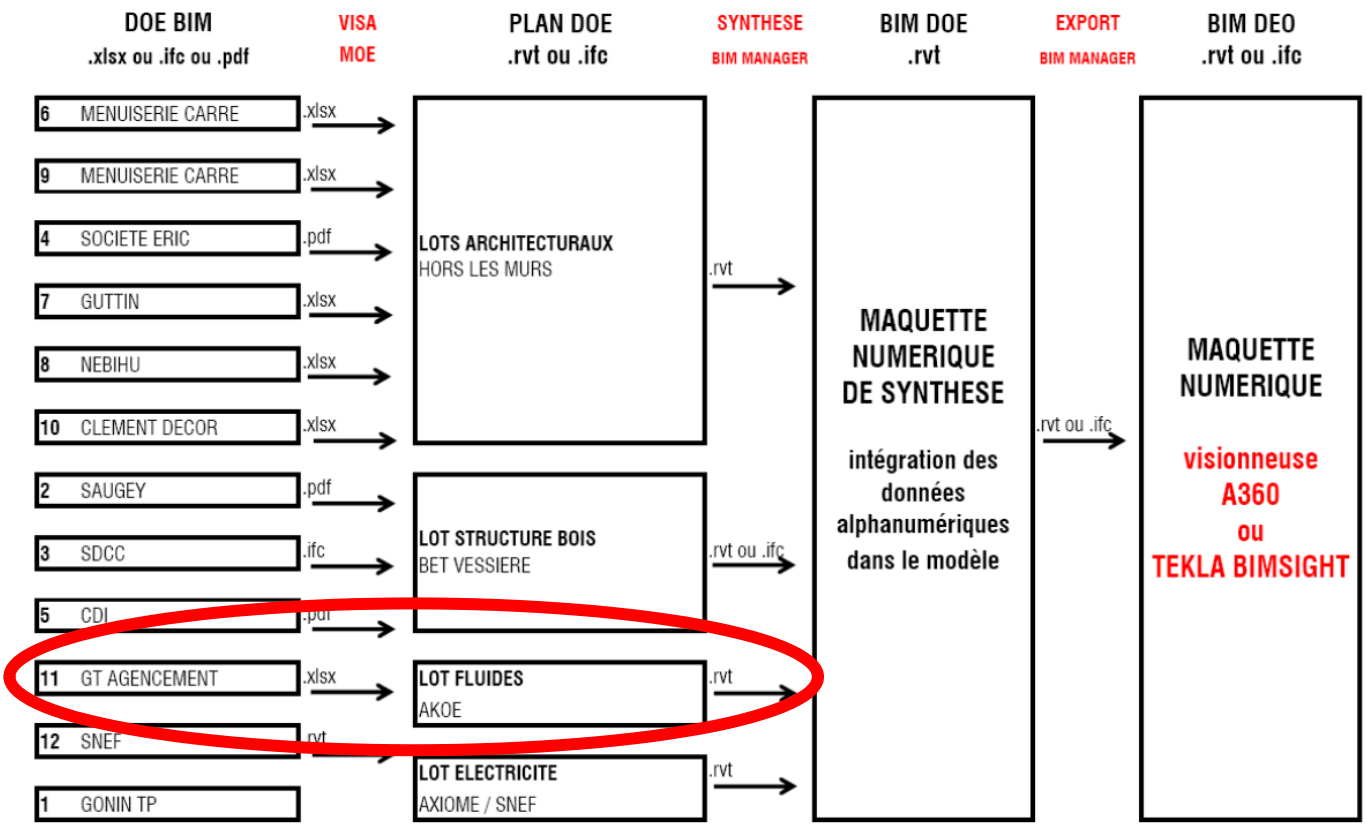


Illustration 35: on site complex BEP

8.2.7. what are the requests for the building companies design office ?

Building companies design office can include lots of data in their model for a use on site.
For instance, (see Ill.36) the company indicated the type and brand of a ventilator device. This information may be used on site, for instance to check that the product delivered on site is correct.

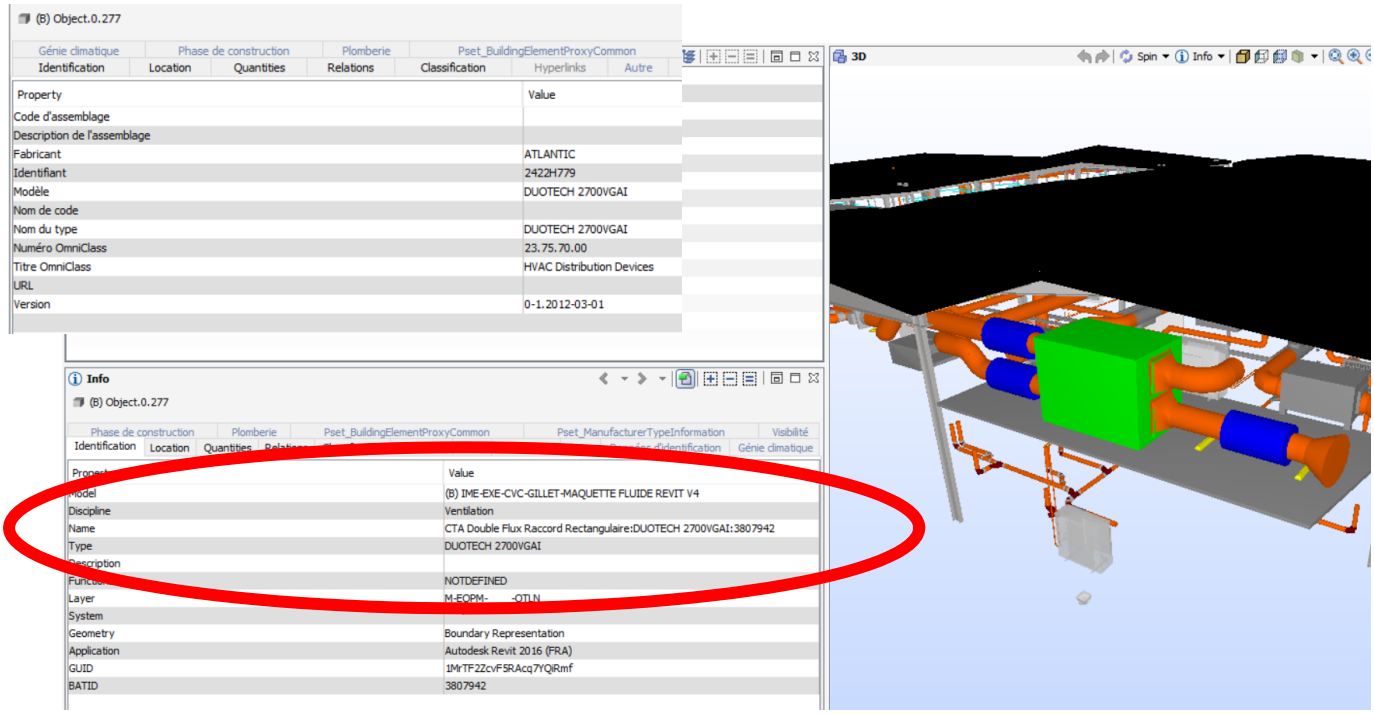


Illustration 36: type of ventilator specification

One of the principal aim of this part of the training will be to get, from the trainees, a list of the data, documents, information, … even specific extracts of the BIM model, that would be most useful for the on site workers. The trainer could, then, transfer these needs in terms of BIM data to the design office for a more appropriate BIM design of the project.
Such exchanges would greatly improve the cross trade and cross level collaboration on a project.

9. ON site use of a MEP BIM model by site workers

At this phase of the project (launching of the on-site work), the design of a MEP system and its BIM model have been either done or visualized by the company management team and/or design office.
This next step will be conducted by the site manager & foremen in order to prepare and organize the work on site, dedicated to the implementation of a ventilation system, with the help of the BIM model.
This chapter presents the 6 different steps these stakeholders have to go through in order to be able to efficiently use a BIM model on the site work, and to train on-site blue workers to manipulate a BIM model with a tablet.
Annex_2.2 will present an extensive example of the different slides that have been used on the Carrousel pilot project.

9.1. The main steps that constitute the training content frame for on-site workers

9.1.1. Identification of the key BIM stakeholders

The site manager & foremen have to be able to understand the roles and identify the key BIM stakeholders :

- client's BIM manager
- BIM coordinator of the project manager MEP design office
- BIM coordinator of the building company MEP design office

9.1.2. Ability to handle the general BIM model

The site manager & foremen have to be able to make a BIM visit of a project. To that end, the have to learn how to use a viewer and all related tools (see § 3 of annex 2-Carrousel in this document).

9.1.3. Manipulation of the project BIM models

In this step, the site manager & foremen will go deeper in the BIMplement project BIM models to enter the project through the different trade BIM models. That means cross-trade skills to grasp the project concept as seen by the other stake holders, and to think of their impacts on his own batch.
A few examples are given here below.

Illustration 37 is a view of an architect BIM model. His intention is to design 2 different types of false ceiling. However, when the ventilation batch will have to start his work, none of them will be realised. The site foremen have to be aware of these technical provisions and so, have a better understanding of the ventilation technical design that may seem strange otherwise.

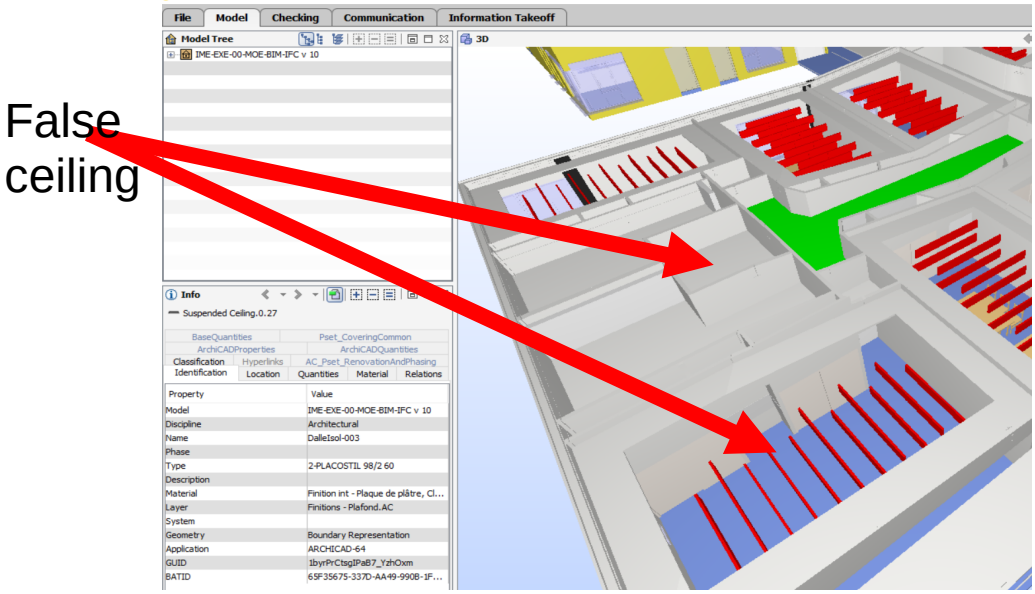


Illustration 37: visualisation of different types of false ceilings

Illustration 38 comes from a structure BIM model. Explore this model will, for instance, allow the foremen to see what are the different materials they will have to deal with for duct attachment, or choosing mounting brackets, drill holes, ...

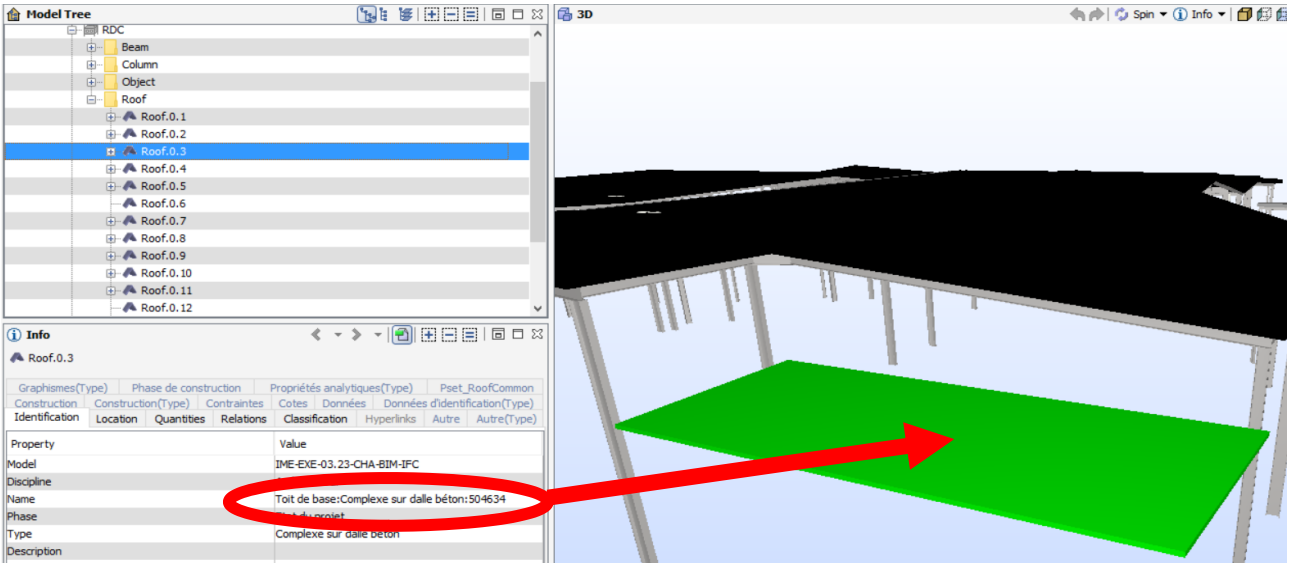


Illustration 38: visualisation of different types of load bearing structure material

All project BIM models have to be looked over (architect, structure, joinery, MEP, electricity, ...). In fact , the ventilation batch may be impacted by any other batch.
For instance, the following illustration (see Ill.39)shows the electricity model and indicates where plugs have been foreseen in the boiler room.

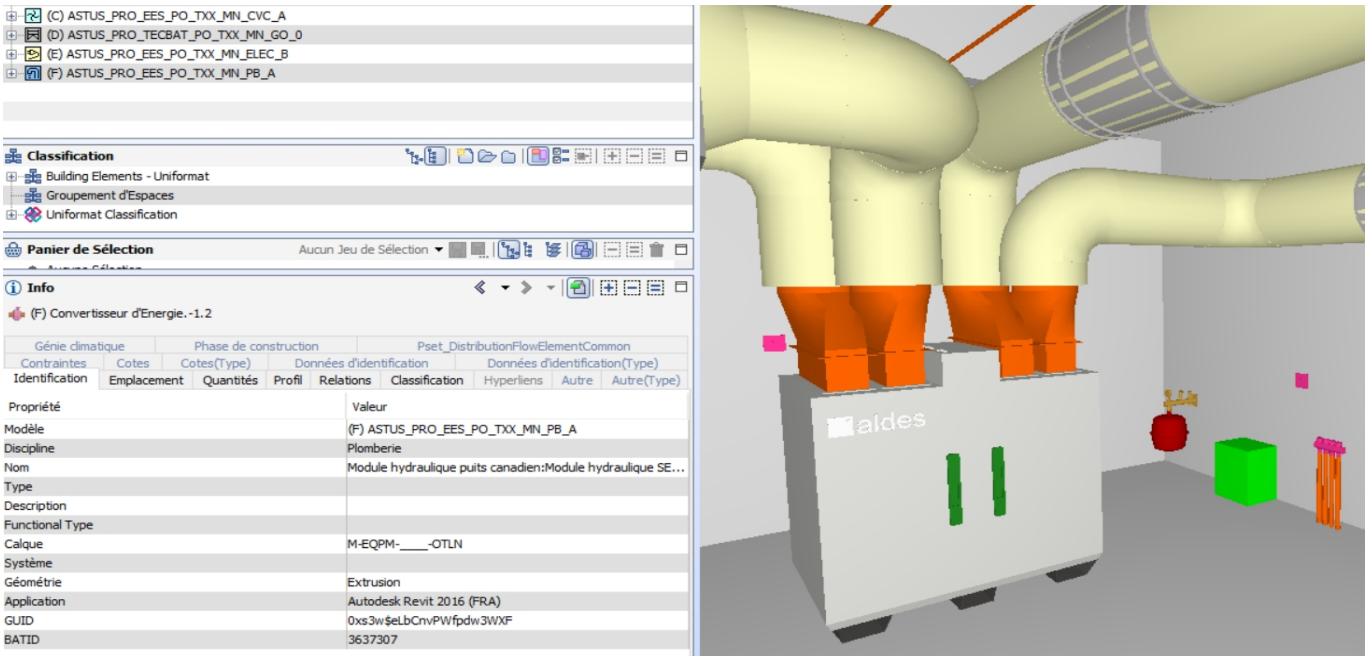


Illustration 39: visualisation of elements from the electricity BIM model

9.1.4. Handling of the MEP model by site managers

In this next step, the site manager and foremen work on their own batch, ventilation.
Instead of using “classical” 2D plans, the objective is to explore the ventilation batch through the MEP BIM model. It may have been designed by the company design office or by the project manager design office.
The interest for working with the 3D BIM model is to :

- see what has to be implemented in 3 dimensions, which is quite important for ventilation whose element cross a lot of partitions and go all through the building.
- Identify all objects and systems that constitute the networks
- identify the possible conflicts and report them

The first level is to identify the smallest element : BIM objects.
Here below (see Ill.40)is presented a global ventilation system alone. The site manager and foremen can identify the different elements and type of elements of the ventilation system.
They also are able to place the network within the building and get a 3D view of the work to be implemented.

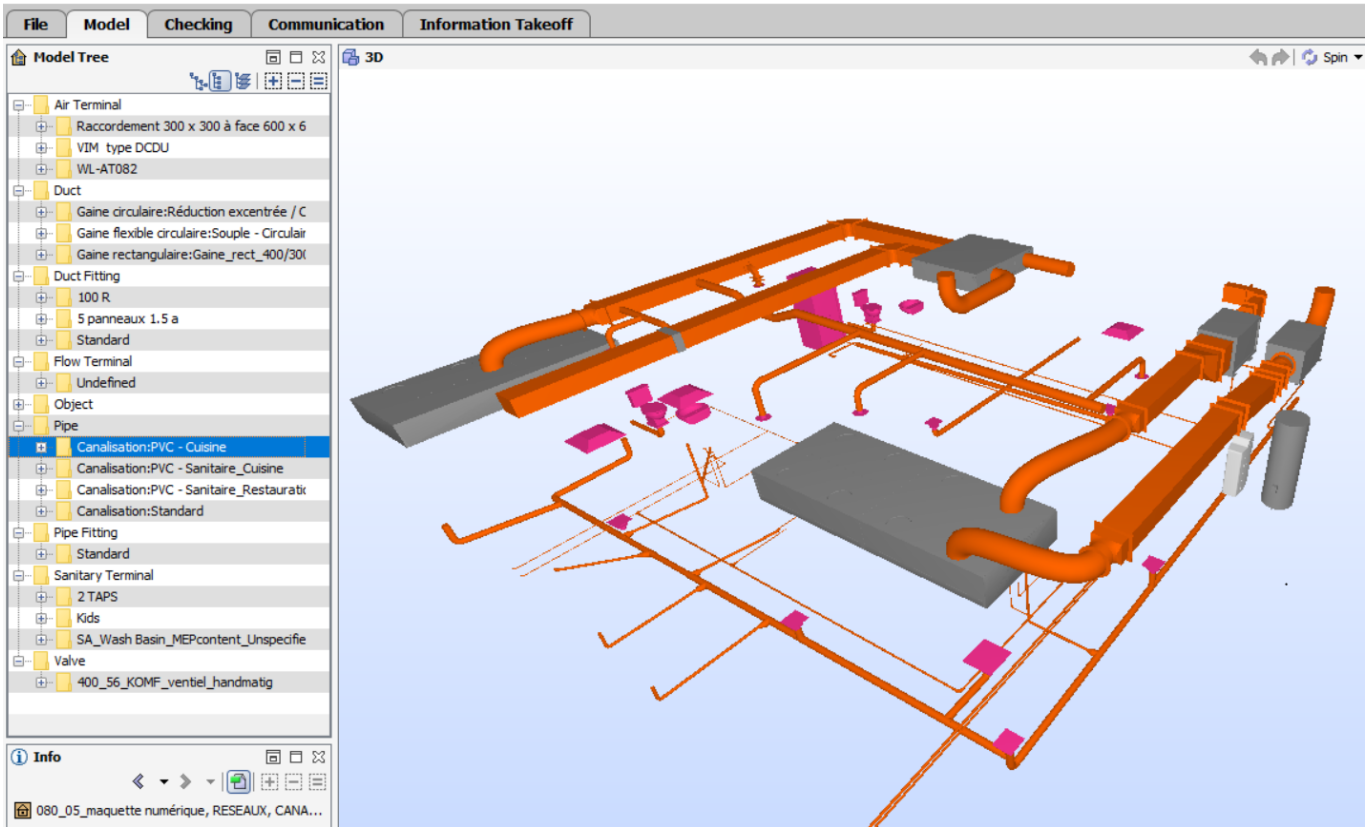


Illustration 40: visualize the complete MEP network

The second level consist in visualizing the different systems that should have been identified during the design in the BIM model (see Ill.41). It gives a better information for the quality implementation of the work to be done.

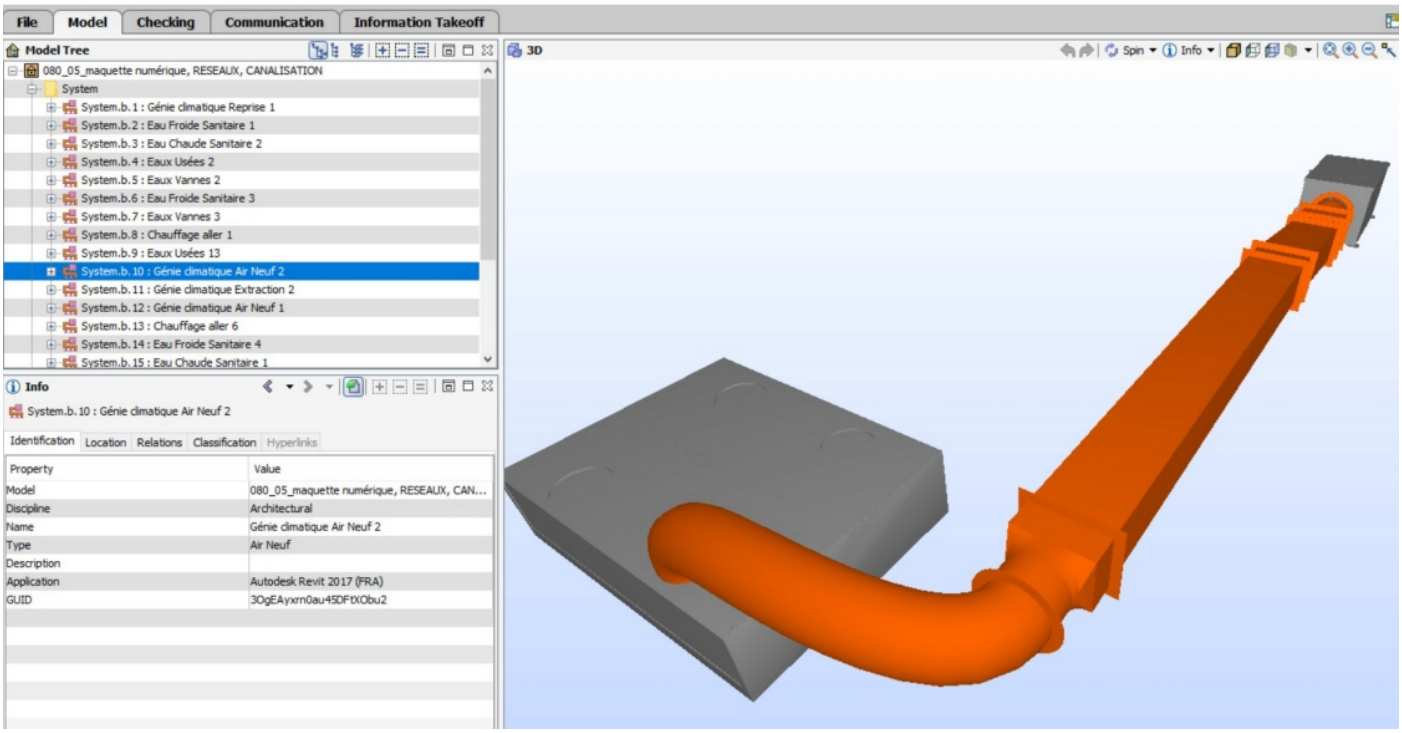


Illustration 41: visualization of a system (part of the whole network)

Once objects and system are identified, it will be possible to check if additional documents have been inserted in the model.
Here below (see Ill.42), the company design office has attached a technical document on how to install a boiler.

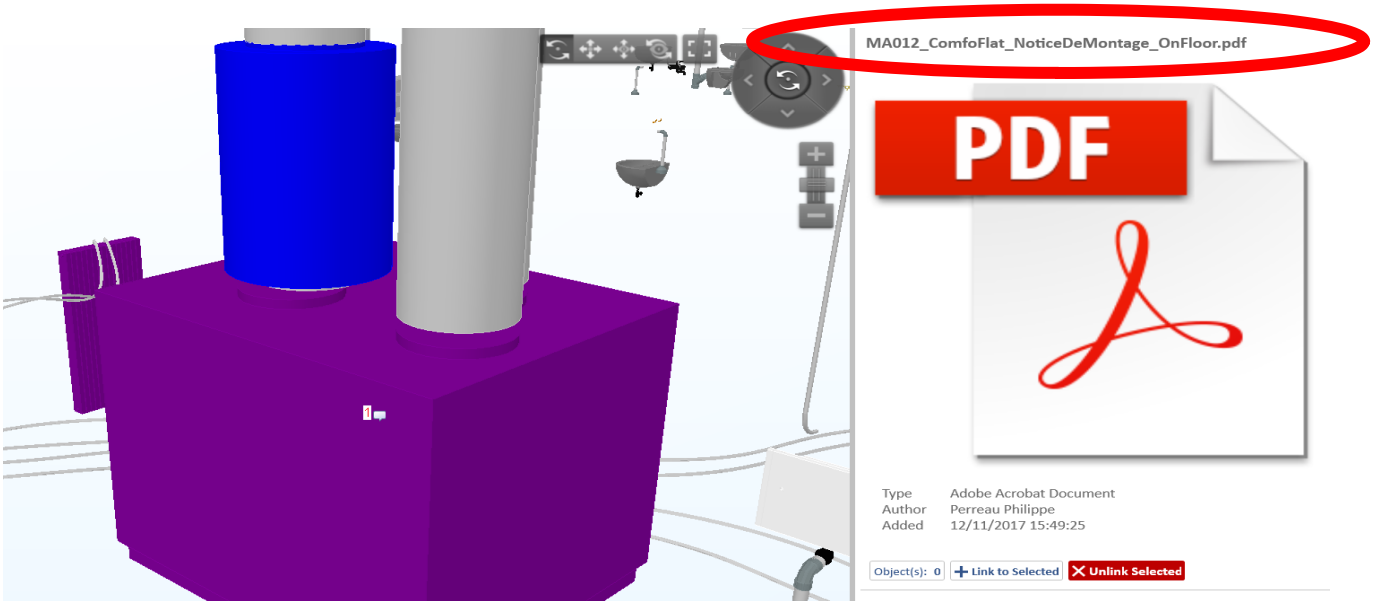


Illustration 42: assembly instruction attached to a boiler IFC_object

At this point, the foremen will be able to identify conflicts or possible problems to the design office (company or project manager), or ask for more information, while using the BCF exchange device (see Ill.43).

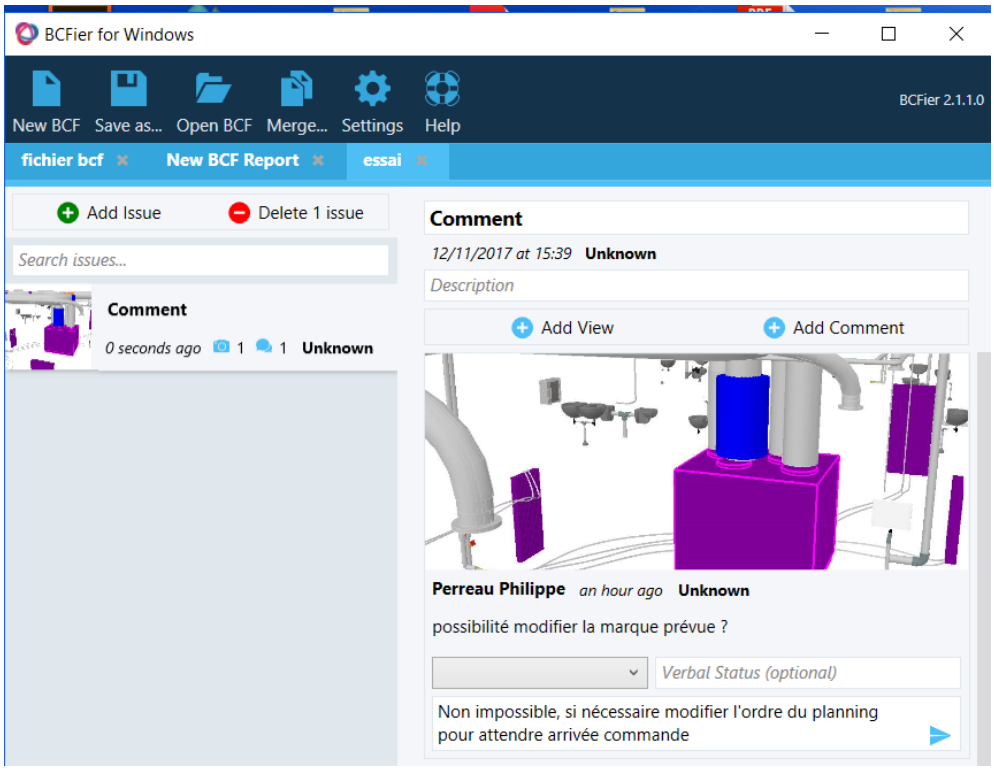


Illustration 43: BCF exchange based on the BIM model

9.1.5. launching of the construction work

At the very beginning of the construction work, there are meetings with all building companies. It is the place to exchange around the 3D BIM model (instead of 2D paper plans) and visualize the identified weak points, and/or conflict risks between batches.
This is also the place to build and examine a 4D planing (see Ill.44)that will make explicit and visual the virtual project progress.

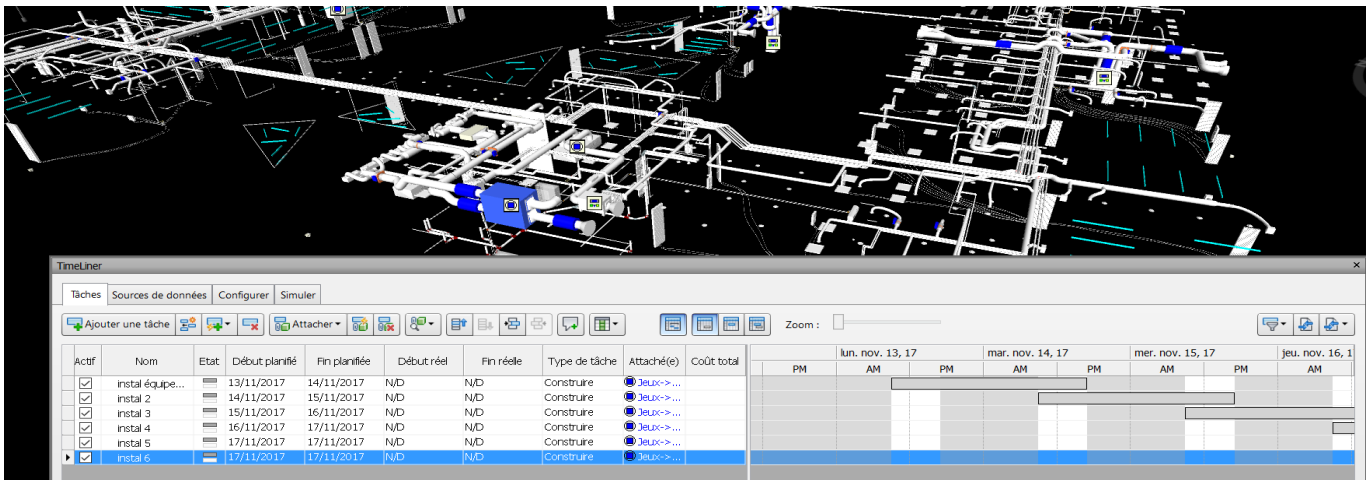


Illustration 44: visualisation of a 4D planning

These meetings will also be the place, for instance, to discuss about blockout, and check their position, size, … (see Ill.45)

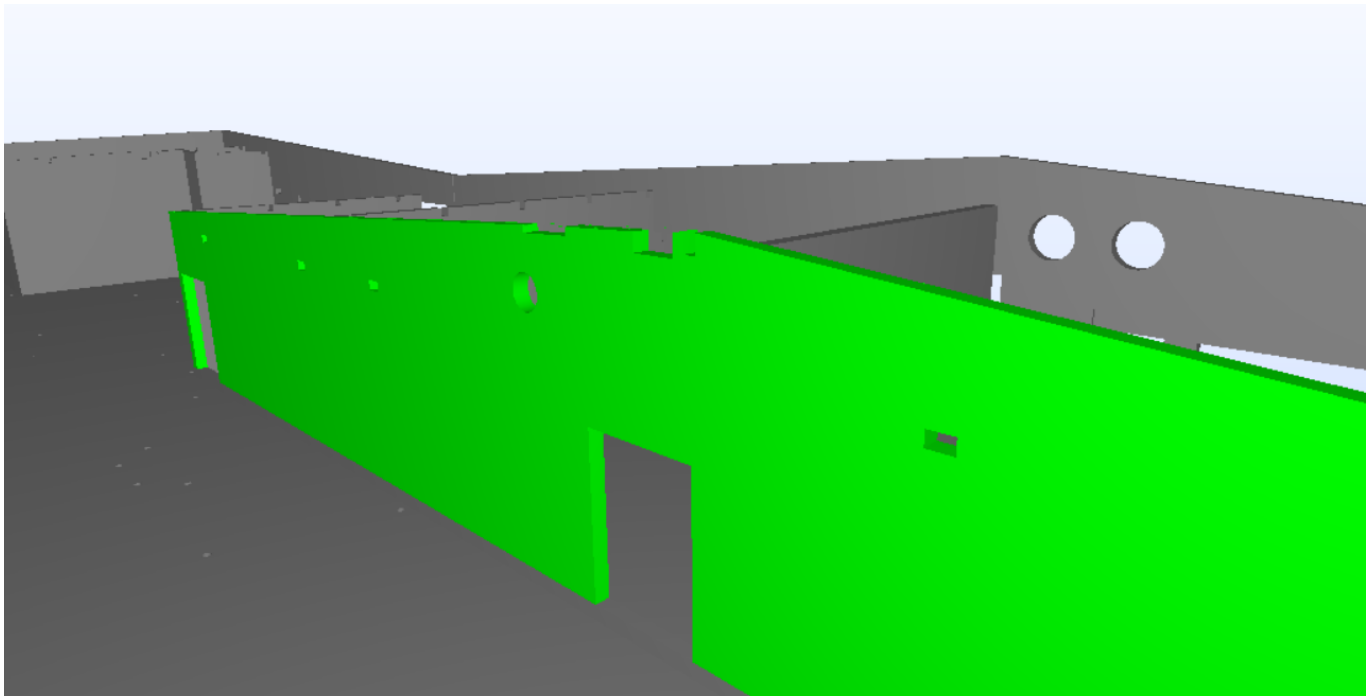


Illustration 45: visualisation of blockout

At the beginning of the construction work, or when it is time to, the foremen will have to place orders for materials and devices, or to verify the order made by the company and check the

delivery on site. The foremen will have to be check that the BIM model is updated, specially with ventilation because this batch is implemented latter than the other.
The use of a BIM model on site will be very helpful to verify the possible difference between the original design and the work actually implemented.

9.1.6. Place orders

To place or verify order, the foremen can export, via a table (see Ill.46), all object related to his batch.

	A	B	C	D	E
1	**Flow Terminal**				
2					
3	**Name**	**Tag**	**Object Class**	**Layer Assignment Name**	**GlobalId**
4	Bouche de soufflage:Raccordement 300 x 300 à face 600 x 600:712422	712422	Flow terminal	M-HVAC-CDFF-OTLN	0x_v4ps6T5DfK1uBtiacAx
5	Bouche de soufflage:Raccordement 300 x 300 à face 600 x 600:712429	712429	Flow terminal	M-HVAC-CDFF-OTLN	0x_v4ps6T5DfK1uBtiacAm
6	S4R_Waterloo Air Terminals_AV:WL-AT082:741042	741042	Flow terminal	M-HVAC-CDFF-OTLN	0erRWWlV55Gv$Ij9_QvCIo
7	S4R_Waterloo Air Terminals_AV:VIM type DCDU:904163	904163	Flow terminal	M-HVAC-CDFF-OTLN	1L2GKDK650WQdgSr0m1a3n
8	S4R_Waterloo Air Terminals_AV:VIM type DCDU:922162	922162	Flow terminal	M-HVAC-CDFF-OTLN	0O7MPKM7XAoxzonZKqy2Dk
9	S4R_Waterloo Air Terminals_AV:VIM type DCDU:922975	922975	Flow terminal	M-HVAC-CDFF-OTLN	0IBfz2uLP6fhUwNPTZEfcc
10	S4R_Waterloo Air Terminals_AV:VIM type DCDU:923054	923054	Flow terminal	M-HVAC-CDFF-OTLN	0IBfz2uLP6fhUwNPTZEfbN
11	S4R_Waterloo Air Terminals_AV:VIM type DCDU:923746	923746	Flow terminal	M-HVAC-CDFF-OTLN	2OfakJeGP0t8w8ezdQKyBv
12	S4R_Waterloo Air Terminals_AV:VIM type DCDU:923822	923822	Flow terminal	M-HVAC-CDFF-OTLN	2OfakJeGP0t8w8ezdQKy8r
13	S4R_Waterloo Air Terminals_AV:VIM type DCDU:923869	923869	Flow terminal	M-HVAC-CDFF-OTLN	2OfakJeGP0t8w8ezdQKy96
14	S4R_Waterloo Air Terminals_AV:VIM type DCDU:924014	924014	Flow terminal	M-HVAC-CDFF-OTLN	2OfakJeGP0t8w8ezdQKyFr
15	Bouche de soufflage:Raccordement 300 x 300 à face 600 x 600:974830	974830	Flow terminal	M-HVAC-CDFF-OTLN	0ydt_mDEf97eFc4LgHQhql
16					

Illustration 46: excel export of data related to ventilation

An important point to present and explain is how to use of industrial/commercial BIM objects issued from e-catalogs (see Ill.47).

Illustration 47: ALDES e-catalog

9.1.7. BIM model presentation to the site workers

Launching of the ventilation batch on site is also the moment to introduce BIM models to to on-site workers.

A training session, simpler than the one given to the foremen should be implemented. At the end of the (½ day) training session, on site worker should be able to visualize the work they have to implement, with the help of a tablet or on a computer installed on site.
They also will have access to :

- technical documentation for a better quality implementation
- possibility to attached pictures and comments on the work implemented
- quality control files to be filled up, possibly online

9.2. Training content : understand and analyse a MEP model for on-site workers (cf. 9.1.4)

The previous chapter aimed at explaining what the site manager and foremen have to be able to do with a BIM model, and how and when they have to acquire these skills.
This 9.2 chapter presents the contents of a training session for site manager and foremen.
The training objective is for them to be able to make a full analysis of a BIM model, but only on a "passive" way. This means they will not have to modify the model, only read it, use its data and make comments.

9.2.1. Context of the training session for site manager and foremen

During the BIMplement project, this training session is based on the construction project to be implemented by the trainees. This chapter is focused exclusively on "how to use a MEP
At the end of the training session, It would be most important and interesting to have the trainees express their additional needs toward the BIM model : what are the missing data that would be useful to them.

This Chapter will present only a small part of the slide show. The comprehensive collection of the slides presented during the Carrousel training session can be seen in Annex_2.
Bimplement trainers will be able, from this example to adapt their training content, both to the trainees and to the real project. The objective is to give the trainees the means to get a clear view of the project and to be able to get the needed data. The points that will presented in the slide show have to be carefully chosen so that the trainees get the real value added of the BIM model.

9.2.2. Analyze the project MEP BIM model (cf. §8.1.3)

This chapter is also dedicated to on-site users (site manager, foremen, blue collar workers). As presented in the beginning of §8, their use of a BIM model will be done with the help of different freeware viewers. It will be important, when getting to their own core business and skills (MEP for instance) to train them to get with BIM a better view of their part, better than what they have experimented , some time for years with 2-D plans and a bunch of written documents.

Depending of the viewer, and if the BIM model design has actually been done in good conditions, the on-site workers will be able to get precise informations on objects.

Example with SOLIBRI Model Viewer. Illustration 48 shows an entire blower system, including all constitutive elements.
On the left side, it is possible to show other systems designed in the same BIM model.

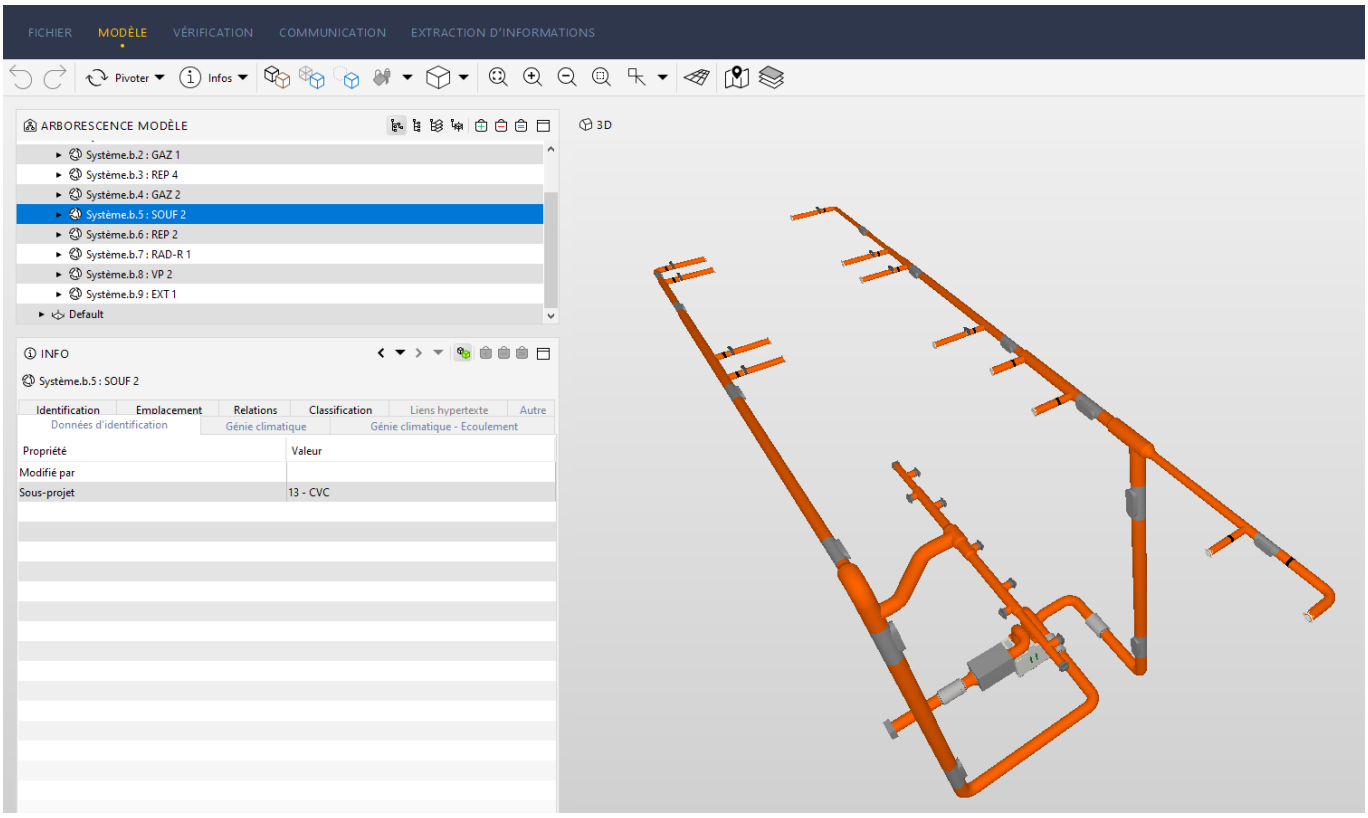


Illustration 48: Blower system

Upon selecting one element, one can have information on this sole element.
Here below (see Ill.49), blower regulation device. It will allow the system to have two different air flows : one, a minimum hygienic air flow, two a higher level of air flow in case of specific pollution (humidity, CO^2, …) or increase of users.

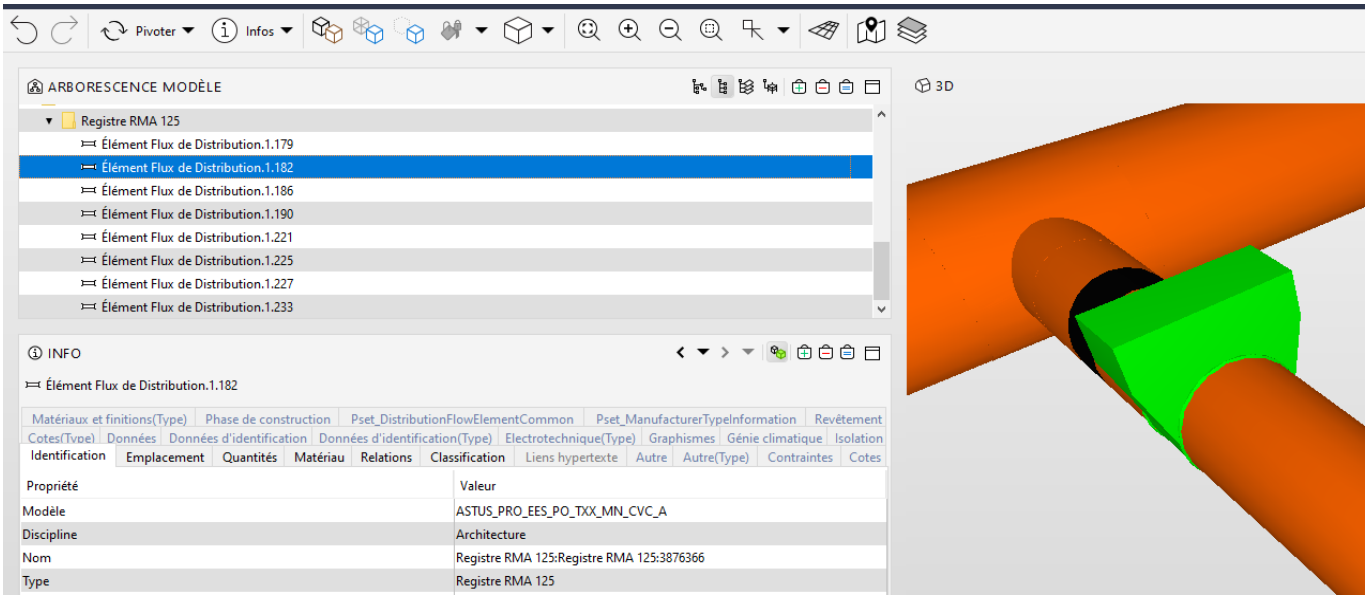


Illustration 49: Blower regulation device

With Navisworks Freedom, in illustration 50 are displayed several icons introduced by the design office with Navisworks. With the help of the freeware Navisworks Freedom, it is possible to get the type of ventilation device, and directly, with the tab “links”, get to the internet site of the producer.

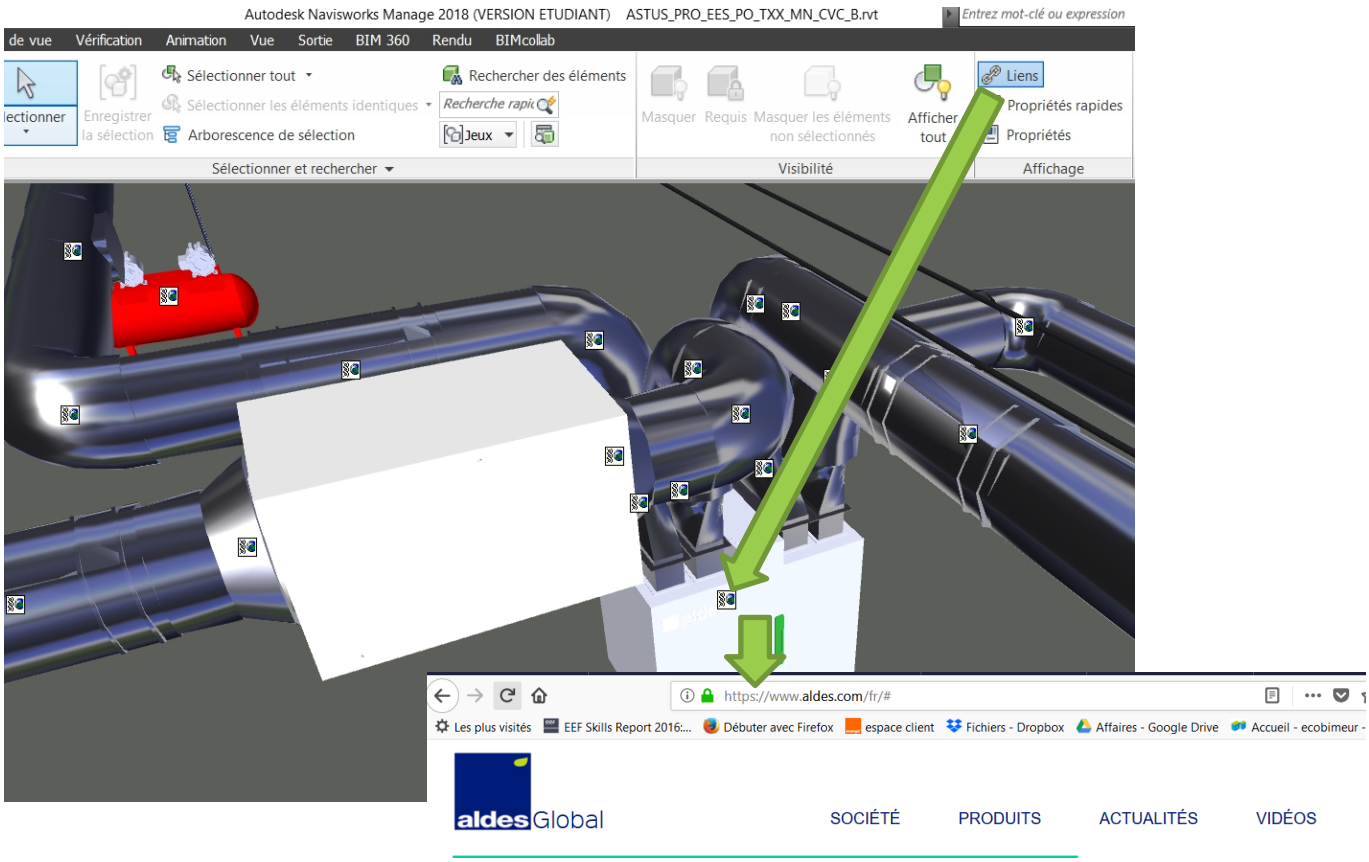


Illustration 50: get information on objects

9.2.3. Impacts of the other BIM models on a MEP model (cf. §9.1.4)

In addition to checking their own trade BIM model (MEP), site manager and foremen have to situate the object(s) they will implement within the whole building site. The objective is to evaluate the impact of their own work on the other batches, and vice versa.
Accordingly, the trainees will learn what is the "IfcSpaceObject", and learn how to check what MEP elements are in which space. This activity will be realized with a federated Design model, using one of the available viewers.

In the following example (see Ill.51), one can visualize that in the light green space, there are several equipments indicated in the left side tab "Equipements".

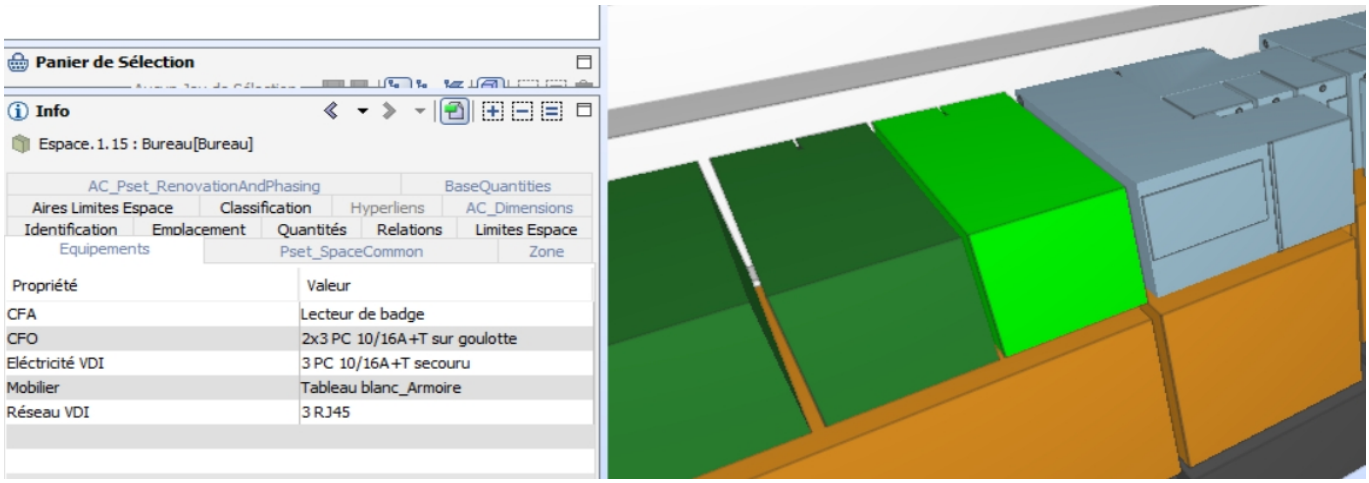


Illustration 51: IfcSpaceObject

The trainees have, to visualize the interferences between the MEP and the Structure BIM Models. In this example, they have to check if a blockout have been made for the orange pipe. Normally, it is the BIM manager's responsibility to check the existence of such blockout (see Ill.52).
However, if the partition in this model does not present such device, the foremen can issue a BCF note to the design office.

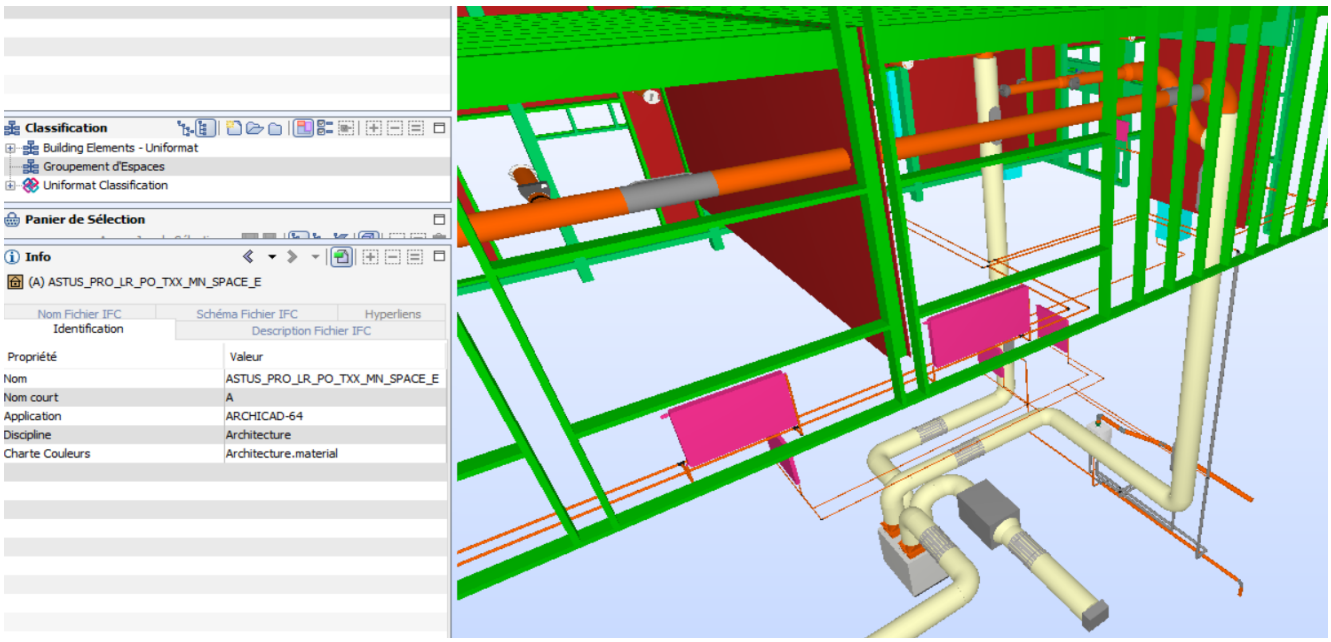


Illustration 52: identification of blockout

In the same way, trainees have to be able to check their MEP model with :
- Structure Model
- Electricity
- Plumbing (if not included in MEP)
- Joinery
- Interior completion (false ceiling for instance)

In this example (see Ill.53), the viewer show that there might be a conflict between the orange pipe and the green false ceiling. A fastening problem may occur.

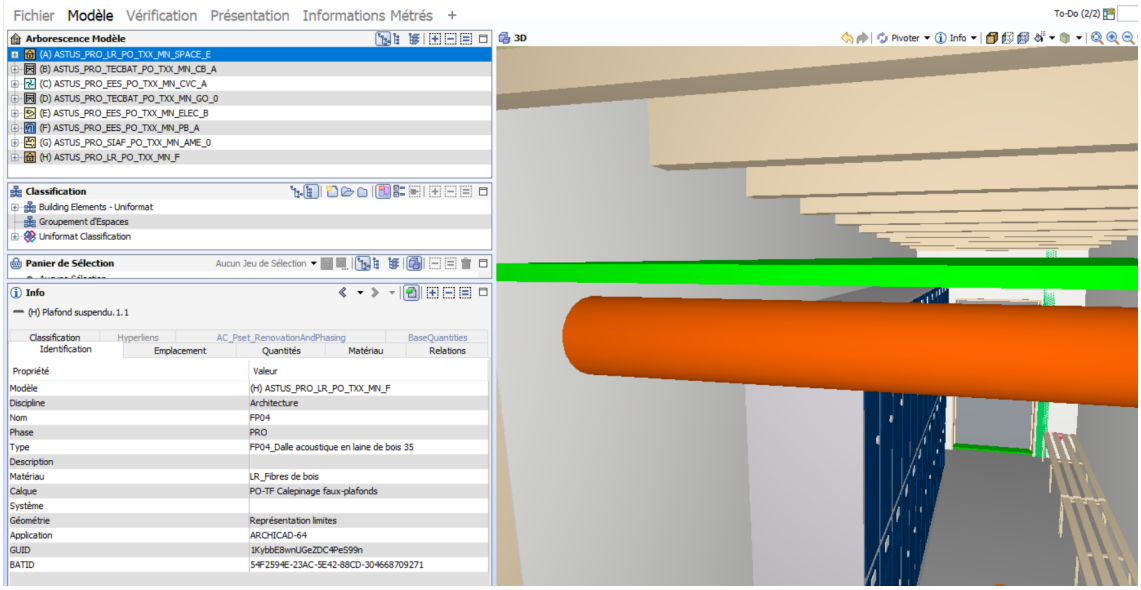


Illustration 53: possible conflict between false ceiling and MEP

When there are many devices in a technical space, it will be useful to check their right positions and identifications. The green devices (see Ill.54)is presented in the “identification” tab as the hydraulic device for the Canadian well.

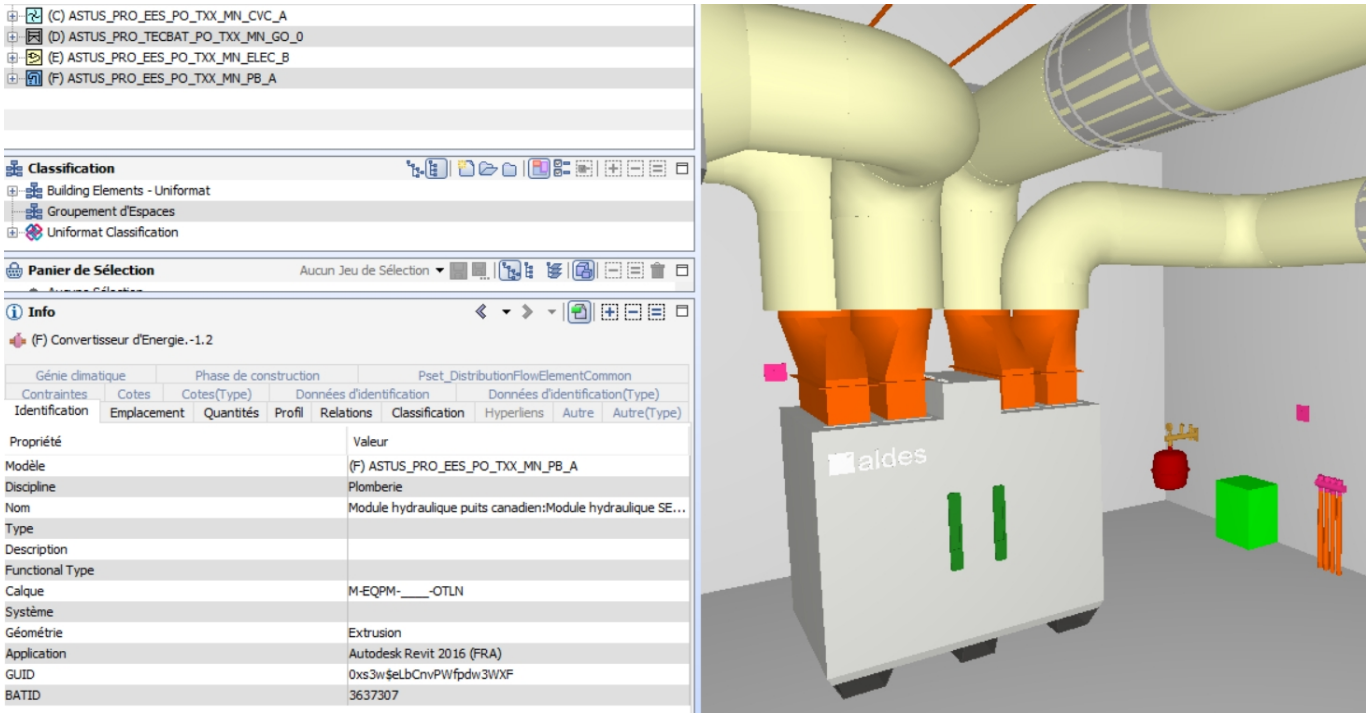


Illustration 54: several devices in a boiler room

This step is also the place to check the object properties, in particular those who will be important for orders. Here for instance (see Ill.), the FireResistanceRating has not been filled by the design office. A BCF note will be used to ask the question.

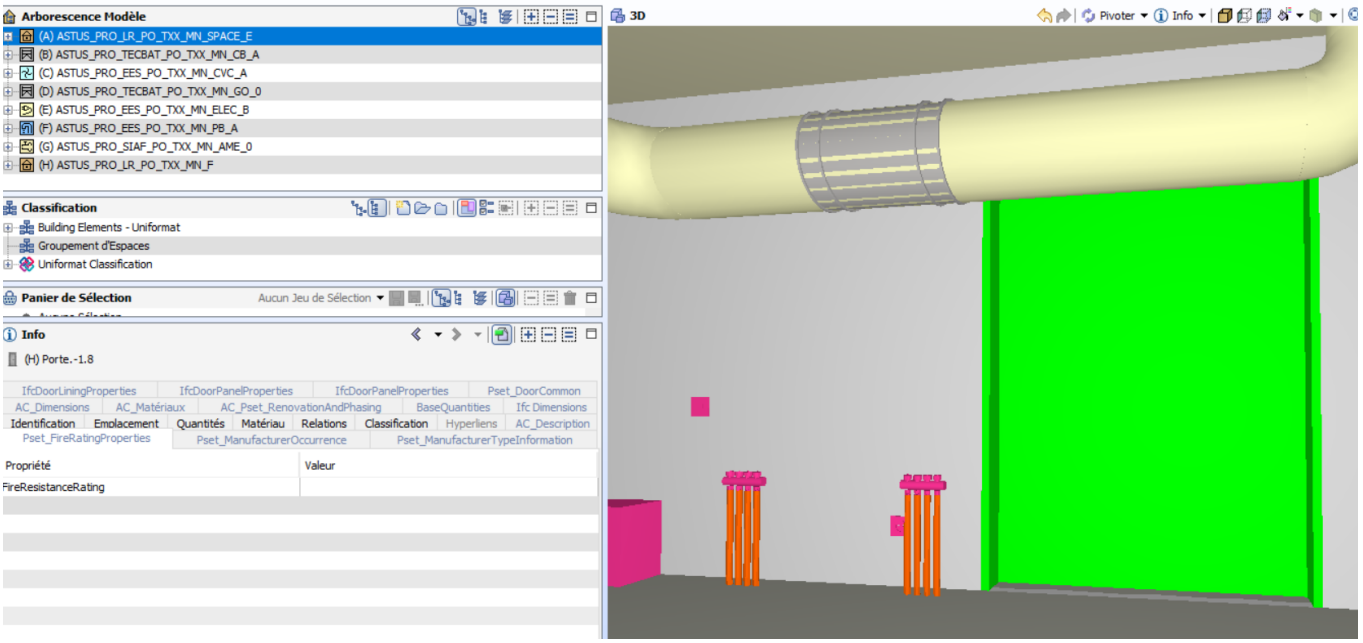


Illustration 55: Object property not filled up

9.3. Check the airtightness weak points, with the “ifc_opening”

This Chapter is definitely experimental, and will be included in the BIMplement pilot field labs.
In fact, there exist almost NO IfcObject related to airtightness.

9.3.1. IfcOpening BIM object

Even if there is no IFC dedicated to airtightness product (such as those presented in D3.3), this question is open, and a company such as Tremco-Illbruck starts working on the subject. This company has created a few 3D objects (see Ill.56), whose use is still not easy to use and implement.
But, up to now, nobody used these BIM objects and the company wishes to find another way of implementing BIM for airtightness products.

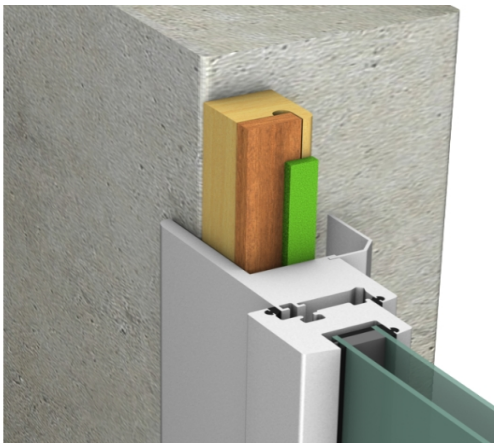


Illustration 56: Tremco-Illbruck 3D objects for joinery

Another approach consists in using the “IfcOpening” element, as a carrier for information.
This object exist already and are used to make holes in an IFC_object such as :
- door and window in a wall
- blockout for pipes … (see Ill.57)

They are created by in all BIM design commercial software. The troubles comes from the fact that not all viewers can make them visible !

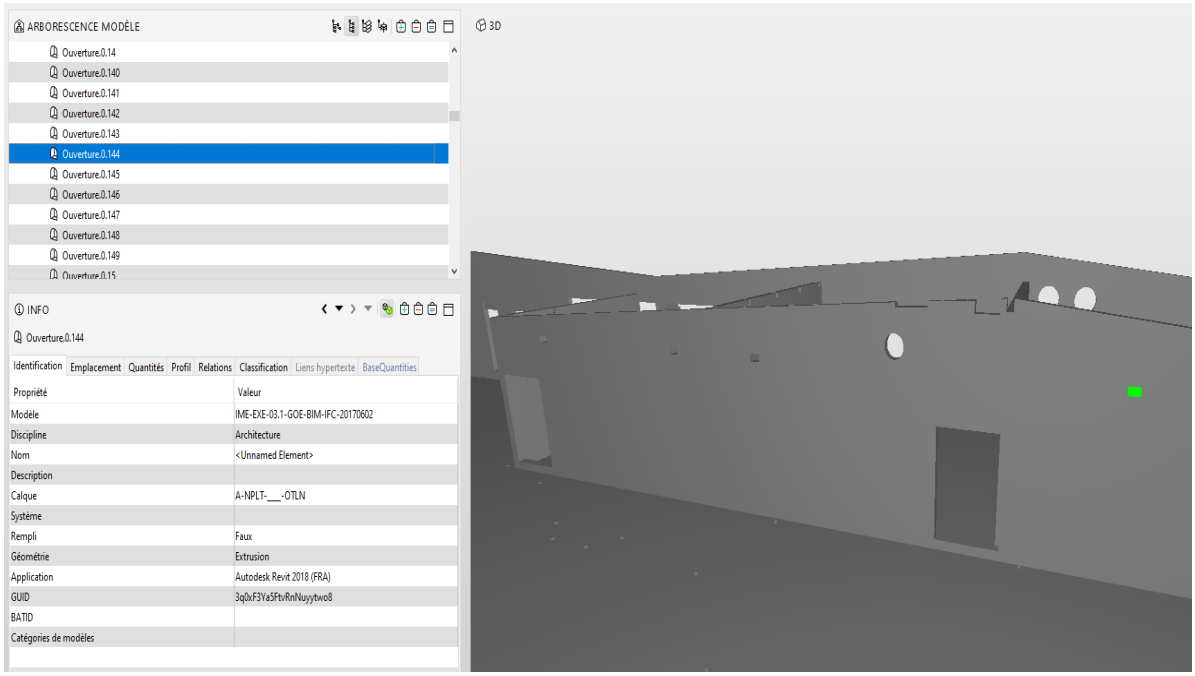


Illustration 57: green spot is an IfcOpening for a blockout

9.3.2. IfcOpening issues and airtightness issues

As for airtightness, the main troubles appear around “holes” : joinery and blockout for pipes.

9.3.2.1. Attach documents to IfcOpeningElement

Because, IfcOpening do exist anyway and are compulsorily created in the BIM model, the proposal is to use these IfcOpening to identify and give information on the airtightness weak points.
These IfcOpening could be linked to a BCF note, or an attached document that would explain and present, for each weak point, what is the solution that has been designed by the design office. These documents could be one of those identified in BIMplement Work Package 3.

The freeware viewer TEKLA BIM SIGHT and the commercial software NAVISWORK can answer this proposal (attached document and/or BCF note).
However, even with these software, IfcOpening are visible if,and if only, the model has been created in good conditions.
For example, in illustration 58, only part of the opening object are visible. Most of them are not ! To use IfcOpening will need a specific training for the design offices.

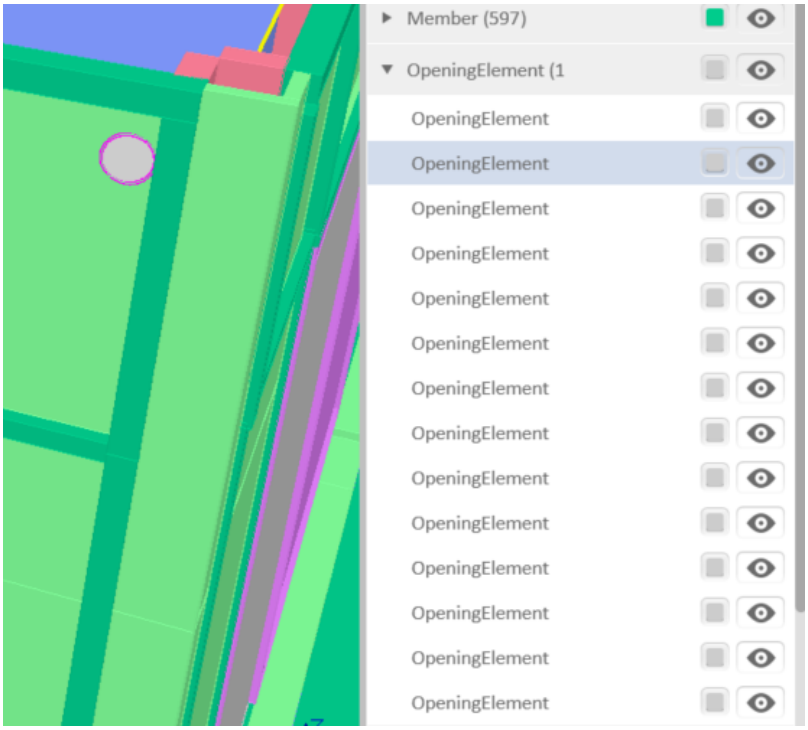


Illustration 58: some visible Opening objects

9.3.2.2. Attach hyperlinks to IfcOpeningElement

Another solution could be :

1. to sort all solutions related to airtightness and document the related solutions
2. create a numerical file that gather all these solutions
3. enter the internet hyperlink in the BIM model (see Ill.59). Clicking on this tab will orient the user to the files with the technical documents related to this opening

This solution is possible with Solibri Model Viewer where an internet link/hyperlink indicates a document.

Propriété	Valeur
Code d'assemblage	
Description de l'assemblage	
Fiche Technique	L:\TRAVAIL\SCAE\IME\02-Plans_Maquettes\DOE E...
Identifiant	356
Nom de code	
Nom du type	*B5*
Numéro OmniClass	*23.80.30.11.17*

Illustration 59: Solibri 's possibility for hyperlink

Here below (see Ill.60)is an example of a tab "hyperlink".

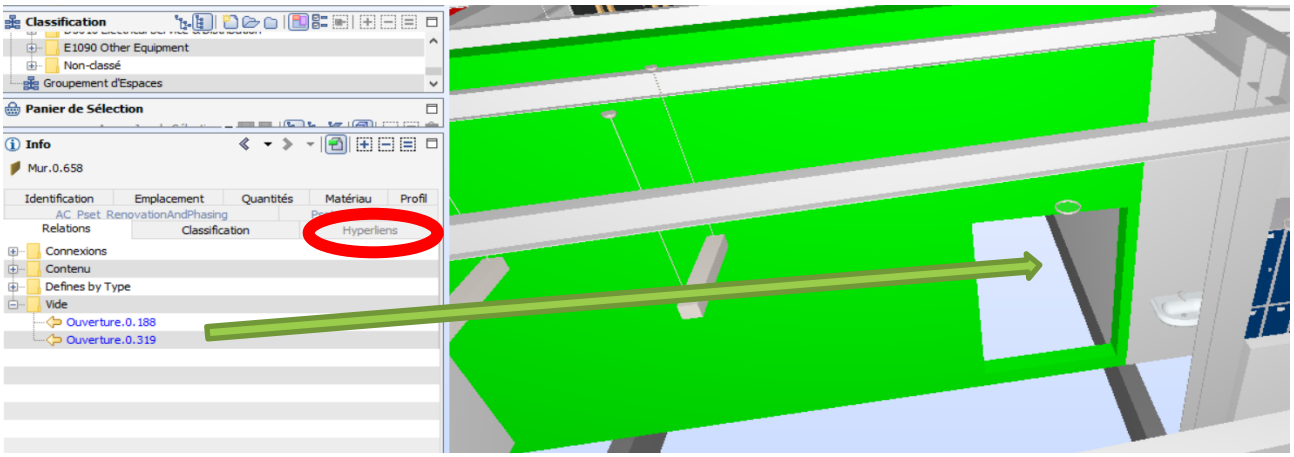


Illustration 60: door as an opening and tab "Hyperlink"

The attached document could also be a 2D-plan where holes are identified , as well as the solutions and airtightness products that have been foreseen by the design office.

9.3.3. viewers capacities to display opening object

The main issue to be worked out is that not all freeware viewers are able to display these IfcOpening, and only a few viewers can actually identify them as BIM objects. For instance :

- TeklaBimSight can display an opening, but the object itself does not appear in the BIM objects nomenclature in the tabs on the right (see Ill.61).

Illustration 61: Tekla BimSight with no opening display

- BIM_Vision can identify openings (see Ill.62)

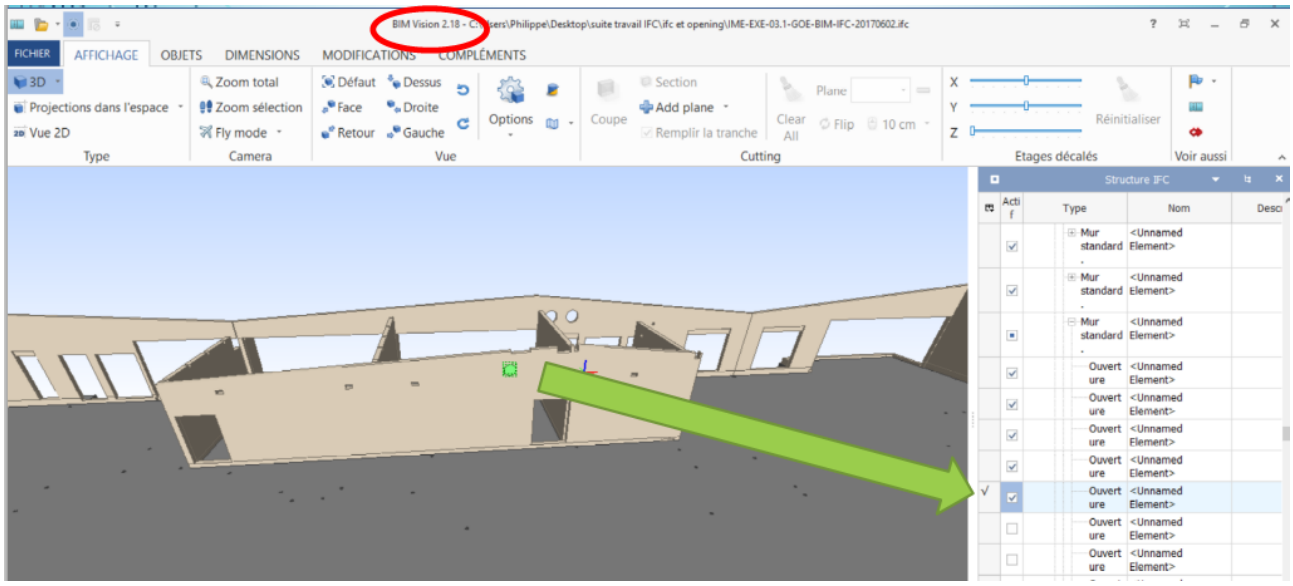


Illustration 62: Opening (ouverture) identified with BIMvision

- Another viewer, EVEBIM actually "sees" openings (see Ill.63), but there is no OpeningObject within the classification ! In the following illustration, there is no opening object connected to the wall.

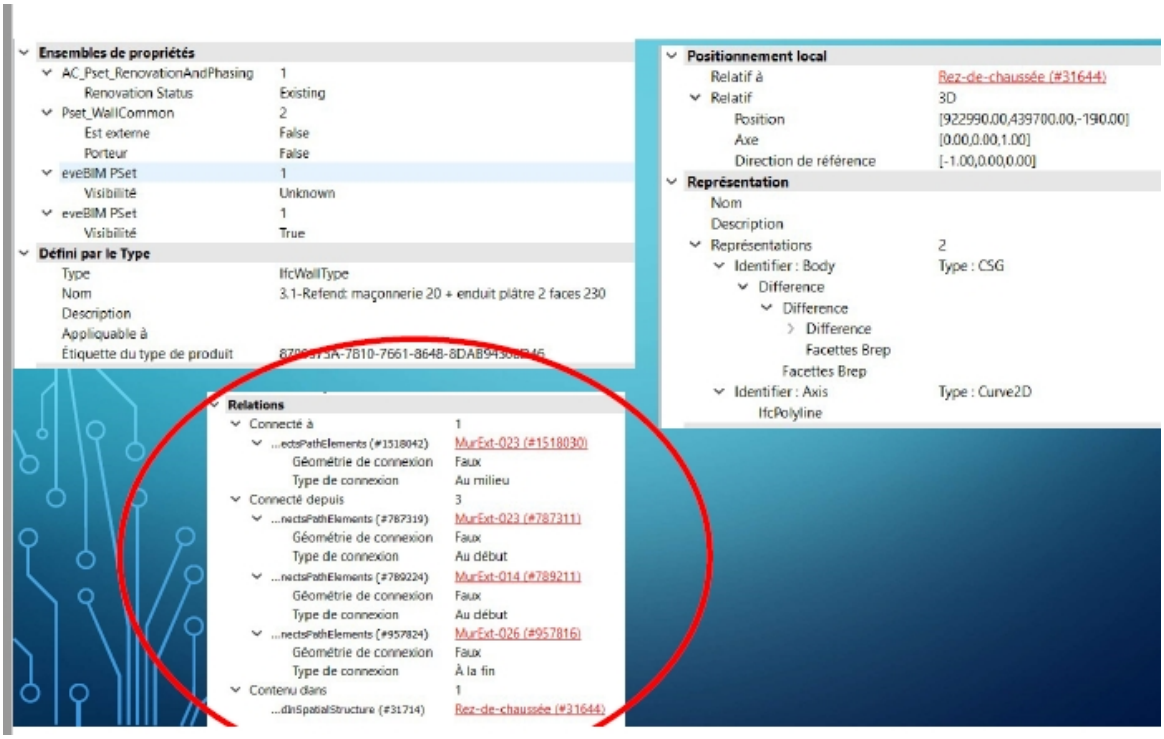


Illustration 63: EVEBIM and opening objects

However, these objects do exist in the IFC code (see Ill.64)!

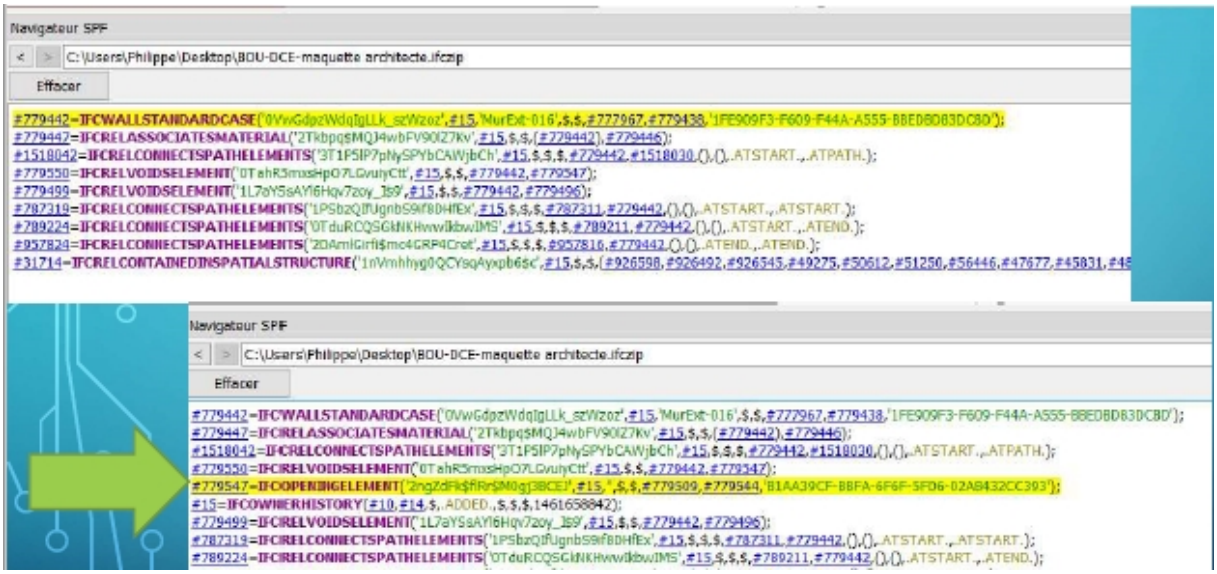


Illustration 64: EVEBIM opening IFC code

9.3.4. IfcOpening and BIMplement pilot field lab

Within the BIMplement project, an experiment will be conducted on one project at least.
It will consist in implementing both previously proposed solutions. One possibility will also to build a specific airtightness BIM model in order to test under which conditions it will be more efficient for on-site implementation.

A research pilot field lab, within BIMplement, will be developed in order to establish and optimize the possibilities of using IfcOpening as a carrier for airtightness on-site information.
This research will be implemented in collaboration with Illbruck industrial company and also with some software companies.
It will consist in :

- analyse all viewers capacities to display and use opening objects
- analyse the way IfcOpening have to be used in native BIM models for these object to be usable in viewers
- apply the §8.3 solutions to different models realized with different commercial design software for a variety of project and analyse the solutions when using different viewers
- test these solutions on a set of BIMplement experimental projects.

10. BIMplement Kit

The BIMplement Kit is a product of the experimental implementation phase. It aims to answer the needs and constraints of building companies that wish to train their employees when participating in a project with a BIM process.

10.1. BIM training for on-site workers

The BIMplement project highlighted two conflicting observations:
- for BIM to drive to a maximum improvement on the final quality of the construction, it is essential that all execution phase stakeholders, and especially on-site operators, use the models on the worksite, made accessible with freeware viewers and/or collaborative platform by companies,

- it is difficult to organize and carry out training sessions for site workers, from the site manager to the companions and craftsmen, because of the constraints of the construction site, even if the owner imposes these trainings. One of the major constraints is the difficult mobilization of companions and craftsmen for a full day training session.

Based on the experience gained during the BIMplement project, we felt it necessary to design a pedagogical alternative to the current training methods (full day training sessions). References are made to the contents presented in the previous chapters.

10.2. 12 one-hour training modules

The proposed principle is to design a 12-one-hour training sessions, that can be given to site operators by an employee of the company previously trained on the BIM process and the use of viewers, both on the BIM process and use of viewers, and on the use of the Kit BIMplement pedagogical method.
The proposal in this basic model is intended for a company. However, it would be very advantageous to carry it out with several companies, especially those very involved in successful airtightness solutions. The idea is then to deal with this training at the global level of a construction project. Many variants are conceivable, for example :
-Modules 7, 8, 9, 11, 12 are carried out with employees from different companies, allowing a real interoperability between different trades.
-a general contractor providing all the modules for the various team leaders of the subcontracting companies.

The company's in-house trainer will be able to choose the most appropriate schedule to organize his in-house training, and preferably on the construction site, in order :
- not to disrupt the progress of the construction site
- to use the worksite BIM model, which will allow participants to better take ownership of the project and its digital version.

The ultimate goal is to enable participants in this 12-session cycle to acquire the necessary knowledge for the company to participate in a BIM process:
- understand the impact of a "BIM process" on the worksite and the role of site staff
- learn how to handle freeware viewers and to view the project BIM model
- learn how to find useful information
- learn to communicate via notes and documents attached to the model
- understand the use of a 4D schedule

10.3. the BIMplement Kit training-for-trainers programme

The training of trainers will be carried out by the local Master trainer. For each module, examples and videos will be presented so that each trainer can, later on, take up this frame and adapt it to the building site.
The training of trainers will be adapted to the prior knowledge of the trainer. All the following points should be known to the trainer:

- the BIM process
    - understanding the company's place in the BIM process

    - understanding of the responsibilities and roles of all actors
- viewers and platforms
    - manipulation of several viewers and their tools
    - handling a collaborative platform
- understanding of BIMplement pedagogy
    - how to analyse the project BIM model (The project context, & The stakeholders context)
    - Match the critical points of the project and their positioning in the model (General questioning when drafting a BIMplement training course in relation with ventilation and airtightness).
    - preparation of the BIM model for training purposes (Pedagogical BIM contents canvas, to be adapted to each training programme)

It is indeed essential for the training of the building site workers to carried out from pedagogical examples extracted from the current project. This pedagogical method allows :
- the future trainers to compare the digital examples to the reality of the site and thus to make the link in a natural way,
- the site managers to apply the training to the site conditions, in particular concerning the linked documents for a better implementation of technical solutions for critical points.

10.4. The BIMplement Kit training program

It consists in 12 1-hour modules, based on the project that will be implemented by the building companies' trainees. The frame of each module is presented below.

10.4.1. Module 1: Presentation of project BIM models

→ present the project and show its progress with the BIM model

- Using a Viewer to show the visualization of the models (project manager models or execution models)
    - depending on the project, presentation with one of the Viewers that will be used:
        - Viewer IFC
        - Collaborative platform ?
        - Navisworks Freedom
- what is the company's involvement in the BIM process?
    - Extracts of the BIM documents from the call for tender (BIM specification analysis)
- importance of airtightness management[1] and/or other critical points
    - reminder of the stakes (Specify the expected results in terms of energy efficiency)
    - the company's commitments for success

1 Airtightness: during the whole training, airtightness issues will be systematically used as an example in the identification and understanding of critical points and in the use of related documents specifying the requirements of the company's design office and/or project management. This focus is due to :
- first of all, BIM is an integral part of the success on the building site of the energy optimization of the building and also the reminder that this problem can only be successful in the collaboration of the various trades present on the building site.
- a simple quality plan using self-checks carried out by the site staff in conjunction with the model would have the advantage of concreting their implications.

- the objectives of this training
  - use of new tools
  - new needs on the construction site?
  - another form of communication to use

- *Teaching method :*

Adaptation, by the trainer, of the presentation tools to the project

10.4.2. Module 2: Understanding the Viewer provided in the project, generalities

→ learn how to use a viewer (Manipulation of the project BIM models)

- the digital tools of the construction site: Computer, tablet, smartphone
- general understanding of the Viewer use
  - access to models
  - decomposition of the models
    - Per floor
    - Per objects
- the Viewer's basic tools for understanding 3D geometry
  - manipulation of the model (rotation, zoom, visit, ..)
  - how to make cuts

- *Teaching method :*

- sufficient number of tablets on the site (limit the number of participants)
- self handling by participant

10.4.3. Module 3: Using a Viewer to find simple information

→ data in the digital BIM model (Manage the data system)

- ✓ organization of object properties
  - families of properties
  - visualization of all the properties
  - which properties for which object?
  - specific properties for the building site
- ✓ tools to visualize properties
  - the measurement tool (difference with the quotations)

- *Teaching method :*

- sufficient number of tablets on the site (limit the number of participants)
- self handling by participant

10.4.4. Module 4: Using the Viewer to Find More Complex Information

→ complex data in the digital BIM model (in what space are theses objects attached to ?)

- ✓ specific objects and properties
  - spaces and their properties
  - non-standardized objects
  - the "relation" property (IFC)

- ✓ multiple BIM model handling
    - "MEP" models (General questioning when drafting a BIMplement training course in relation with ventilation and airtightness)
    - "structures" models

- *Teaching method :*

present examples that are useful for the participants' everyday job

10.4.5. Module 5: Self-assessment on all Viewer tools

→ self-test of acquired knowledge and skills

- Handling in autonomy: Searching for information that requires the use of all the tools used in the 4 previous modules

- *Teaching method :*

Questionnaire sorted by trade

10.4.6. Module 6: Communicating with the Viewer

→ How to exchange with others

- The different tools that can be used
    - find tools location
    - draft notes / comments / labels
    - Send questions
    - Read answers

- *Teaching method :*

- sufficient number of tablets on the site (limit the number of participants)
- self handling by participant

10.4.7. Module 7: Links between BIM models and documents

→ learn how to locate, read and attach documents to the BIM model (technical document and BIMplement educational material attached inside the BIM model)

- linked documents
    - Methods to link existing docs
    - Methods to link docs to be created (possibilities?)
- Check-list of the different types of documents to be linked

- *Teaching method :*

- sufficient number of tablets on the site (limit the number of participants)
- self handling by participant

*10.4.8. Module 8: Use of links between **models** and documents*

→ use attached documents to improve on-site implementation

- Feedback on needs
    - typology of documents used on the site
    - frequency of use

- other possible documents
- documents to be filled in

- *Teaching method :*

Possible presence of the site foreman, or a representative of the company's design office.
and even possibility to associate a project management representative.

10.4.9. Module 9: Proposal for the organization of the models for the construction site

→ adapt the models to the needs of the site and the operators

- how to make models easily accessible
  - the technical possibilities
  - models and properties adapted to the building site
  - specific properties for the construction site

- *Teaching method :*

Possible presence of the site foreman, or a representative of the company's design office.
and even possibility to associate a project management representative.

10.4.10. Module 10: Links between models and quantification

→ use model quantification tools

- Excel table extracted from the model Place orders
  - verification of orders
  - task organisation

- *Teaching method :*

  - Specific examples to show the calculation of quantities by the site foremen and team leaders
  - or for the verification of quantities by site operators

10.4.11. Module 11: Understand the use of a 4D schedule

→ organisation of the workcamp over time

- Demonstration
- relevance discussion
- communication organization around this type of planning

- *Teaching method :*

For understanding by site foremen and team leaders
or verification by employees

10.4.12. Module 12: Training evaluation and feedback

→ hot evaluation of the training

- Participant Feedback
- participants' ability and capacity to use the tools presented
- Feedback and list of requests for enrichment of the BIM models

A cold evaluation, after a few weeks of use of the models, will make it possible to strongly improve the use of the models and to evaluate the added value on the quality of the implementation.

- *Teaching method :*
  - Exchanges with all the participants,
  - and the representatives of the design offices (project management or company) and the project management team

11. Conclusion

This deliverable is intended to help BIMplement trainers to set up their own training program, adapted to the project they are working on, and to the trainees.
As complementary pedagogical documents:

- Annex 1- example of Zodiak project presents one detailed analyse of the ZODIAK project and explains what has been presented as cross level and cross trade training contents to the project' building companies.
- Annex 2 (2.1 & 2.2) : example of Carrousel project presents the pedagogical documents which had been prepared for the French Pilot project Carrousel, and includes notes to the attention of the trainers in order to explain the pedagogical approach :
  - annex 2.1) to present BIM issues that are different from the Zodiak project',
  - and annex 2.2) to explain the ventilation and airtightness issues in relation with the BIM model. These documents will be part of the BIMplement database.

Annexes to D_4.5

12. Annex 1- example of Zodiak project

D_4.5 : Tools & Training contents for Building companies – Zodiak project
(link drop box :
https://www.dropbox.com/s/ng0iauq9q1tbzvx/D4.5%20%E2%80%93%20Annex1_Tools%26Training%20contents%20for%20Building%20companies%20%E2%80%93%20example%201%20%20the%20Zodiak%20Project_v4-eng.pdf?dl=0))

13. Annex 2 (2.1 & 2.2) : example of Carrousel project

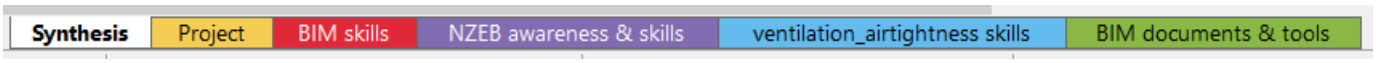
D_4.5 : Tools & Training contents for Building companies – pwt presentation of the first training sessions Carrousel project
Two documents are presented

1) the generic BIM training document ((link drop box : https://www.dropbox.com/s/us01h4ox3epkbeu/D4.5-Annex2.1_building%20companies%20training_Carrousel_bimplement_Fr.pdf?dl=0)
2) the application on the training to airtightness and ventilation. ((link drop box : https://www.dropbox.com/s/dynvicpss17f5dx/D4.5-Annex2.2_airtightness%26ventilation_Carrousel_bimplement_Fr.pdf?dl=0)

These documents are example, drafted for one project and still written in French.
However, BIMplement master trainers will have no difficulties to understand the aims of the presentation.
At the end of the project, there will be as many training presentations as projects, all of them adapted to each project and presented in the identification table (Annexe 3)

14. Annex 3 : Table for the BIMplement project classifications

This table is composed of 6 sheets to be filled up by the BIMplement Master trainer.
One is related to the project context and available BIM documents and specifications, the other ones present how to identify the BIM and nZEB stakeholders skills.



The first sheet is a “synthesis” (here below) of all of these sheets. It give a general view of the project. (link drop box :

- format xlx : https://www.dropbox.com/s/h6n82sz2364erqq/Table-identification_projet_actors_BIM_en_v5_MSexcel%20fixed.xlsx?dl=0
- format OpenOffice : https://www.dropbox.com/s/jzli5smjgdpf218/Table-identification_projet_actors_BIM_en_v5_openoffice.ods?dl=0

name of the project — TEST – V13.1
place : — xxx — France

BIMplement

Project BIM synthesis

DESIGN PHASE

			Client team		BIM manager	
			Project officer	building operator	depends on Client's team	depends on Building company's team
Niv 0	nothing	BIM skills	BIM_Skills_medium_ 3	BIM_Skills_medium_	BIM_Skills_advance	BIM_Skills_advanced_ 5
Niv 1	low	BIM documents	BIM_Text_basic_ 2	BIM_Text_basic_ 3	BIM_Text_basic_ 2	BIM_Text_basic_ 3
Niv 2	basic	**Average BIM : #/5**	**3**		**4.5**	
Niv 3	medium	nZEB awareness	nZEB_Skills_basic_ 2	nZEB_Skills_basic_ 3	nZEB_Skills_basic_ 2	nZEB_Skills_basic_ 3
Niv 4	advance	Ventilation skills	Ventilation_low_ 1	Ventilation_low_ 2	Ventilation_low_ 1	Ventilation_low_ 2
Niv 5	expert	airtightness skills	Airtight_nothing_ 0	Airtight_basic_ 2	Airtight_nothing_ 0	Airtight_basic_ 2
		Average nZEB : #/5	**1.7**		**1.7**	

EXECUTION PHASE

			supervision team OU TECHNICAL TEAMS Of building companies		
			Structure	MEP	Other
Niv 0	nothing	BIM skills	BIM_Skills_basic_ 2	BIM_Skills_basic_ 2	BIM_Skills_basic_ 2
Niv 1	low	BIM documents	BIM_Text_medium_	BIM_Text_medium_	BIM_Text_basic_ 2
Niv 2	basic	**Average BIM : #/5**		**2.5**	
Niv 3	medium	nZEB awareness	nZEB_Skills_basic_ 2	nZEB_Skills_basic_ 3	nZEB_Skills_nothing_ 0
Niv 4	advance	Ventilation skills	Ventilation_advanced	Ventilation_advance	Ventilation_advanced_ 4
Niv 5	expert	airtightness skills	Airtight_advanced_	Airtight_advanced_	Airtight_advanced_ 4
		Average nZEB : #/5		**4.0**	

			Project manager	Technical design office		
			Architect	Structural	MEP	other
Niv 0	nothing	BIM skills	BIM_Skills_advanced_4	BIM_Skills_advance	BIM_Skills_advanced_	BIM_Skills_advanced_ 4
Niv 1	low	BIM documents	BIM_Text_basic_ 2	BIM_Text_basic_ 2	BIM_Text_basic_ 3	BIM_Text_nothing_ 0
Niv 2	basic	**Average BIM : #/5**	**3**		**3.0**	
Niv 3	medium	nZEB awareness	nZEB_Skills_medium_ 3	nZEB_Skills_basic_	nZEB_Skills_basic_ 3	nZEB_Skills_nothing_ 0
Niv 4	advance	Ventilation skills	Ventilation_low_ 1	Ventilation_low_ 1	Ventilation_medium_	Ventilation_nothing_ 0
Niv 5	expert	airtightness skills	Airtight_nothing_ 0	Airtight_nothing_0	Airtight_basic_ 2	Airtight_nothing_ 0
		Average nZEB : #/5	**1.3**		**1.2**	

			On-site workers – Site manager, site foremen		
			Building	MEP	Other
Niv 0	nothing	BIM skills	BIM_Skills_basic_ 2	BIM_Skills_basic_ 2	BIM_Skills_basic_ 2
Niv 1	low	BIM documents	BIM_Text_basic_ 2	BIM_Text_basic_ 3	BIM_Text_nothing_ 0
Niv 2	basic	**Average BIM : #/5**		**1.8**	
Niv 3	medium	nZEB awareness	nZEB_Skills_advanced	nZEB_Skills_advance	nZEB_Skills_advanced_ 4
Niv 4	advance	Ventilation skills	Ventilation_medium_	Ventilation_medium	Ventilation_medium_ 3
Niv 5	expert	airtightness skills	Airtight_medium_ 3	Airtight_medium_ 3	Airtight_medium_ 3
		Average nZEB : #/5		**3.3**	

			On-site workers – Operator		
			Building	MEP	Other
Niv 0	nothing	BIM skills	BIM_Skills_basic_ 2	BIM_Skills_basic_ 2	BIM_Skills_basic_ 2
Niv 1	low	BIM documents	BIM_Text_basic_ 2	BIM_Text_basic_ 3	BIM_Text_nothing_ 0
Niv 2	basic	**Average BIM : #/5**		**1.8**	
Niv 3	medium	nZEB awareness	nZEB_Skills_expert_	nZEB_Skills_expert_	nZEB_Skills_expert_ 5
Niv 4	advance	Ventilation skills	Ventilation_expert_	Ventilation_expert_	Ventilation_expert_ 5
Niv 5	expert	airtightness skills	Airtight_expert_ 5	Airtight_expert_ 5	Airtight_expert_ 5
		Average nZEB : #/5		**5.0**	

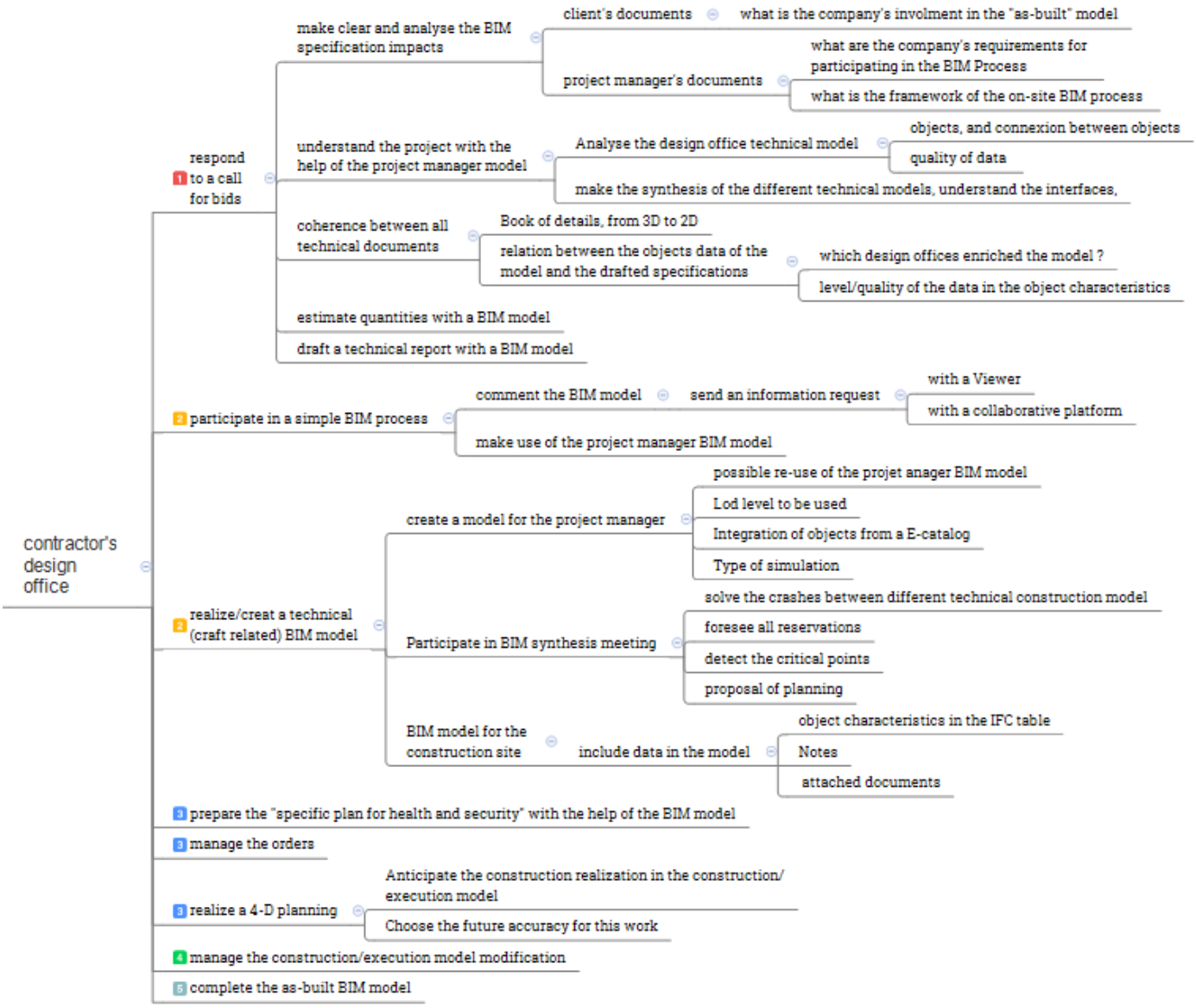
synthesys of project information

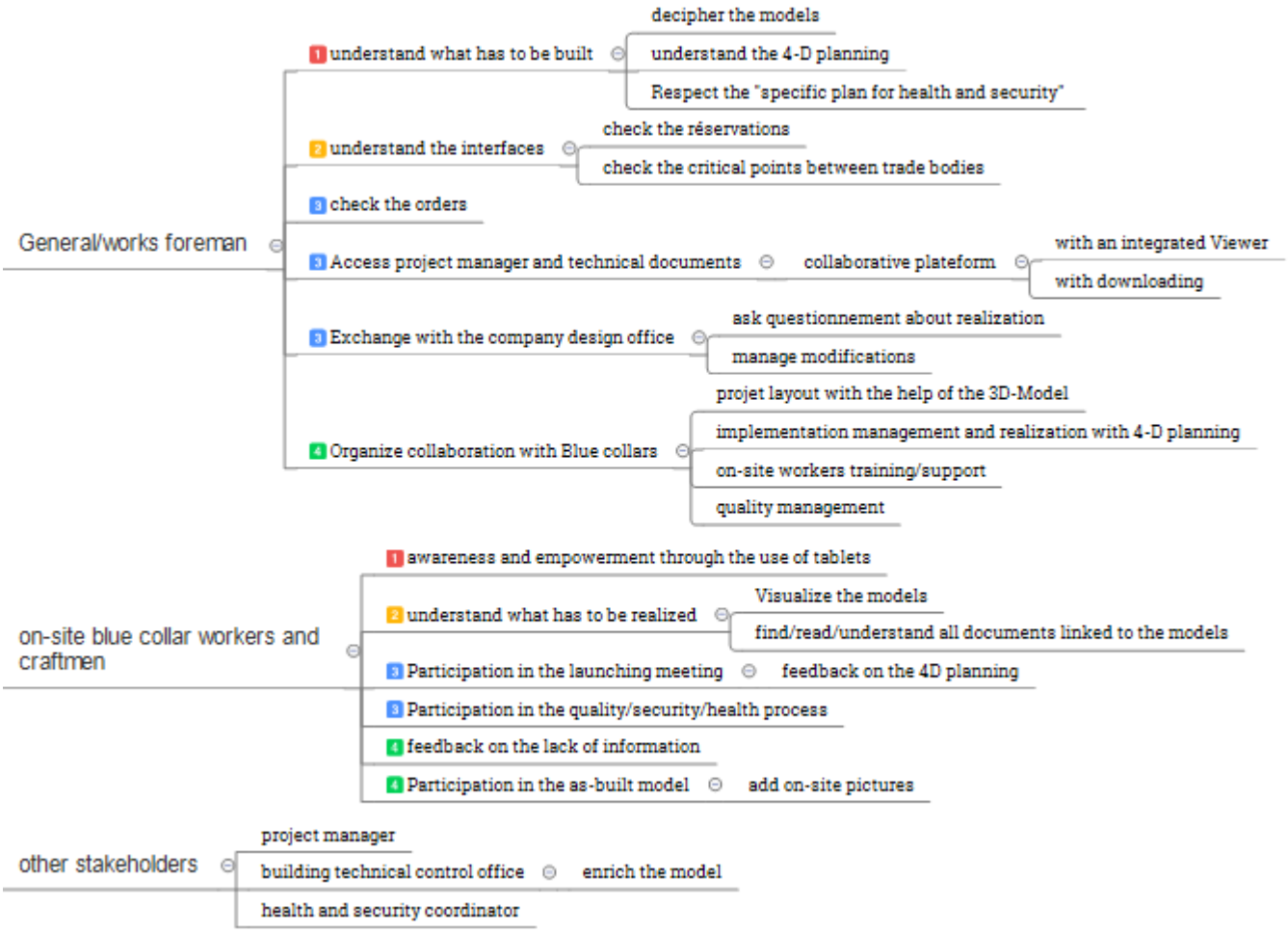
15. Annex 4 : BIM and building companies

Mind Map 1 : BIM on the building site - roles of building companies managers and employees in terms of on-site BIM (2 pages)

This mind map give a detailed view of what the different building companies employees have to care about in terms of BIM for a construction project. These details are given for :

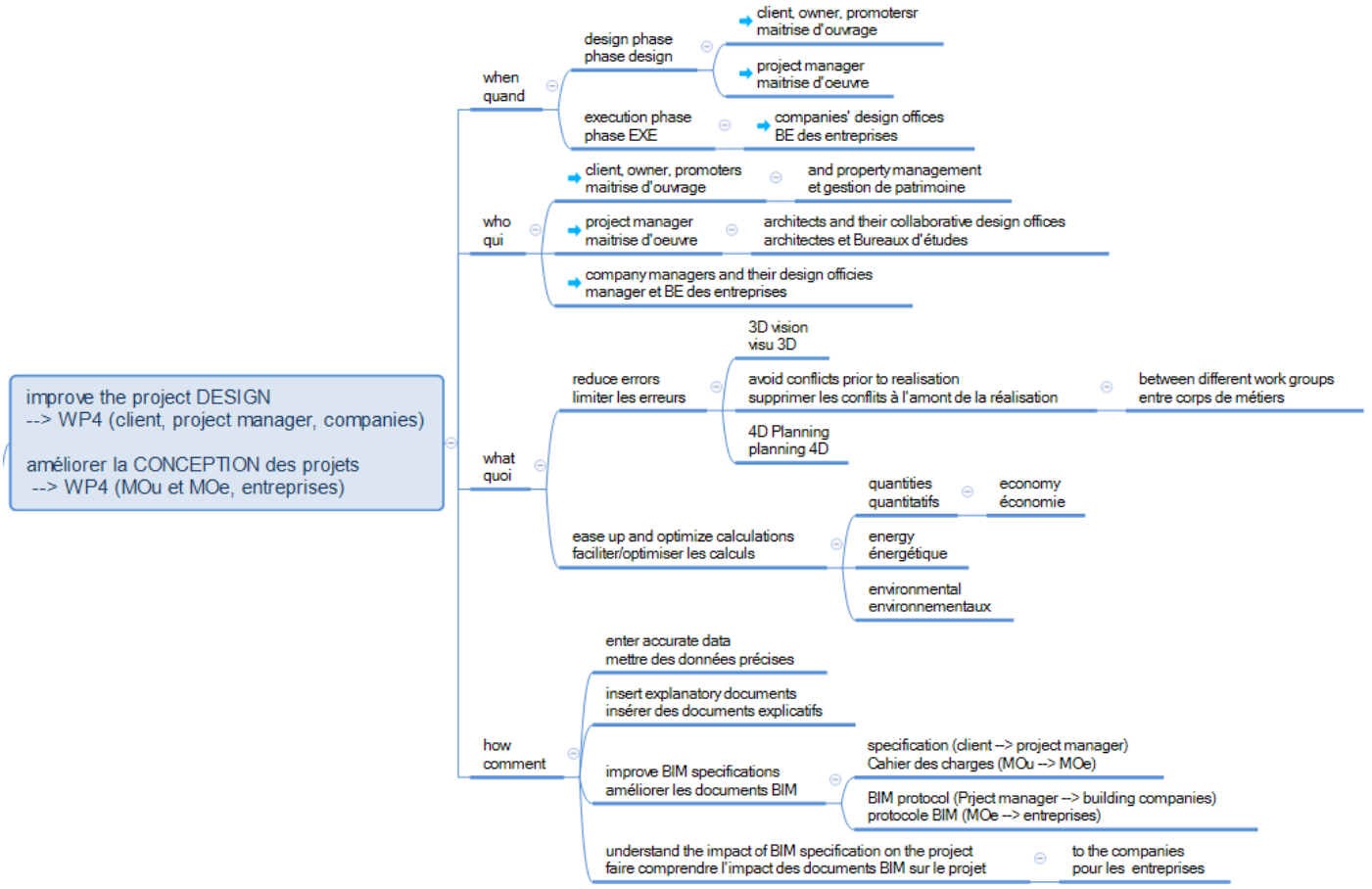
- the contractor's design office
- the General/works foreman
- the on-site blue collar workers and craftsmen
- and other stakeholders working on site

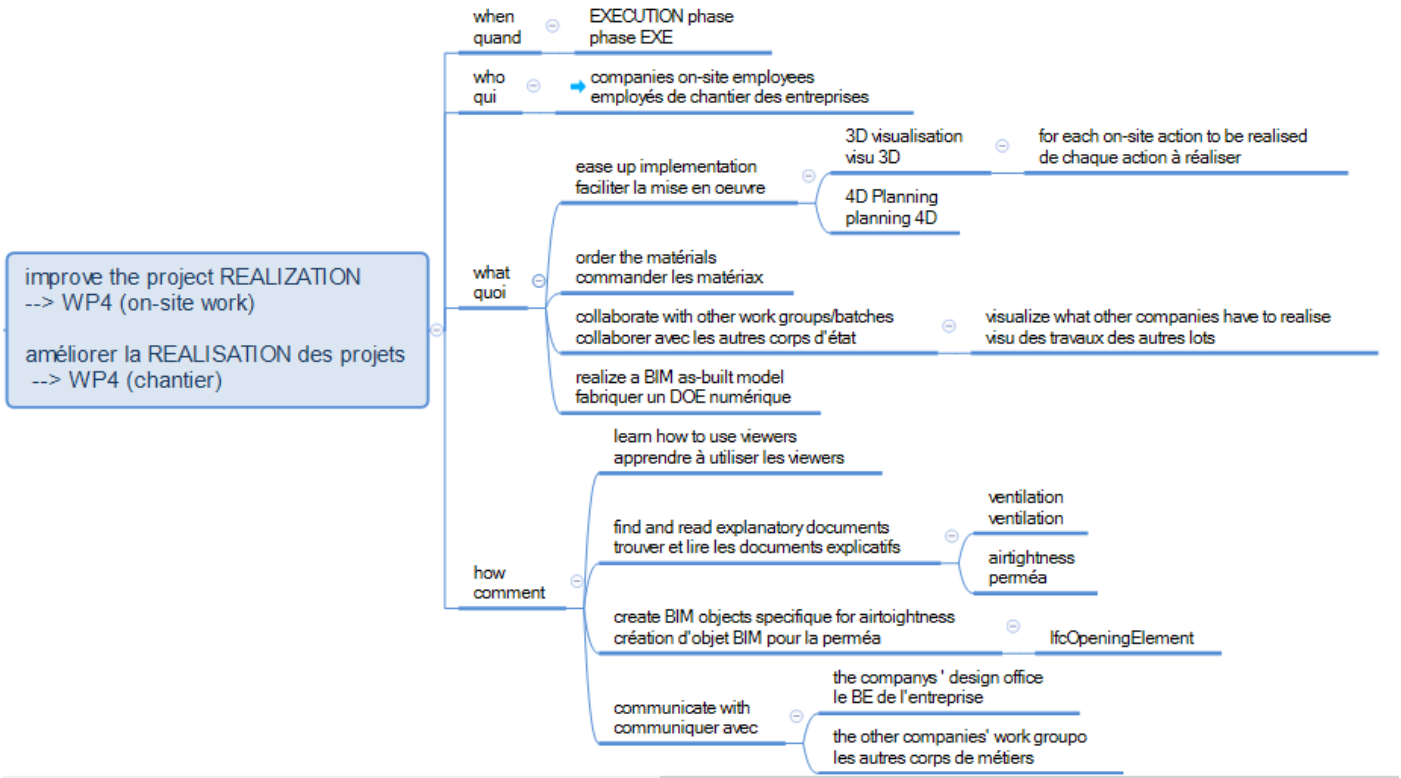


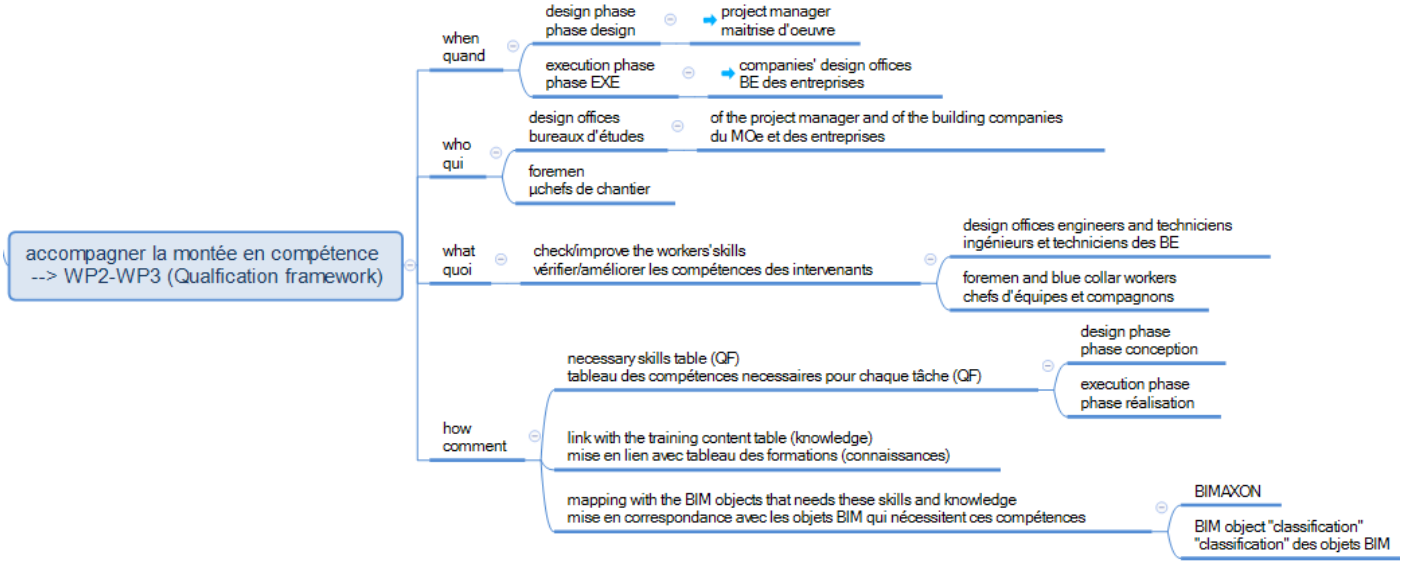

General/works foreman
1 understand what has to be built
decipher the models
understand the 4-D planning
Respect the "specific plan for health and security"
2 understand the interfaces
check the réservations
check the critical points between trade bodies
3 check the orders
3 Access project manager and technical documents
collaborative plateform
with an integrated Viewer
with downloading
3 Exchange with the company design office
ask questionnement about realization
manage modifications
4 Organize collaboration with Blue collars
projet layout with the help of the 3D-Model
implementation management and realization with 4-D planning
on-site workers training/support
quality management
on-site blue collar workers and craftmen
1 awareness and empowerment through the use of tablets
2 understand what has to be realized
Visualize the models
find/read/understand all documents linked to the models
3 Participation in the launching meeting
feedback on the 4D planning
3 Participation in the quality/security/health process
4 feedback on the lack of information
4 Participation in the as-built model
add on-site pictures
other stakeholders
project manager
building technical control office
enrich the model
health and security coordinator

16. Annex 5 : how BIM can improve nZEB

Mind Map 2 : presentation of the project phases where and how BIM will improve project quality

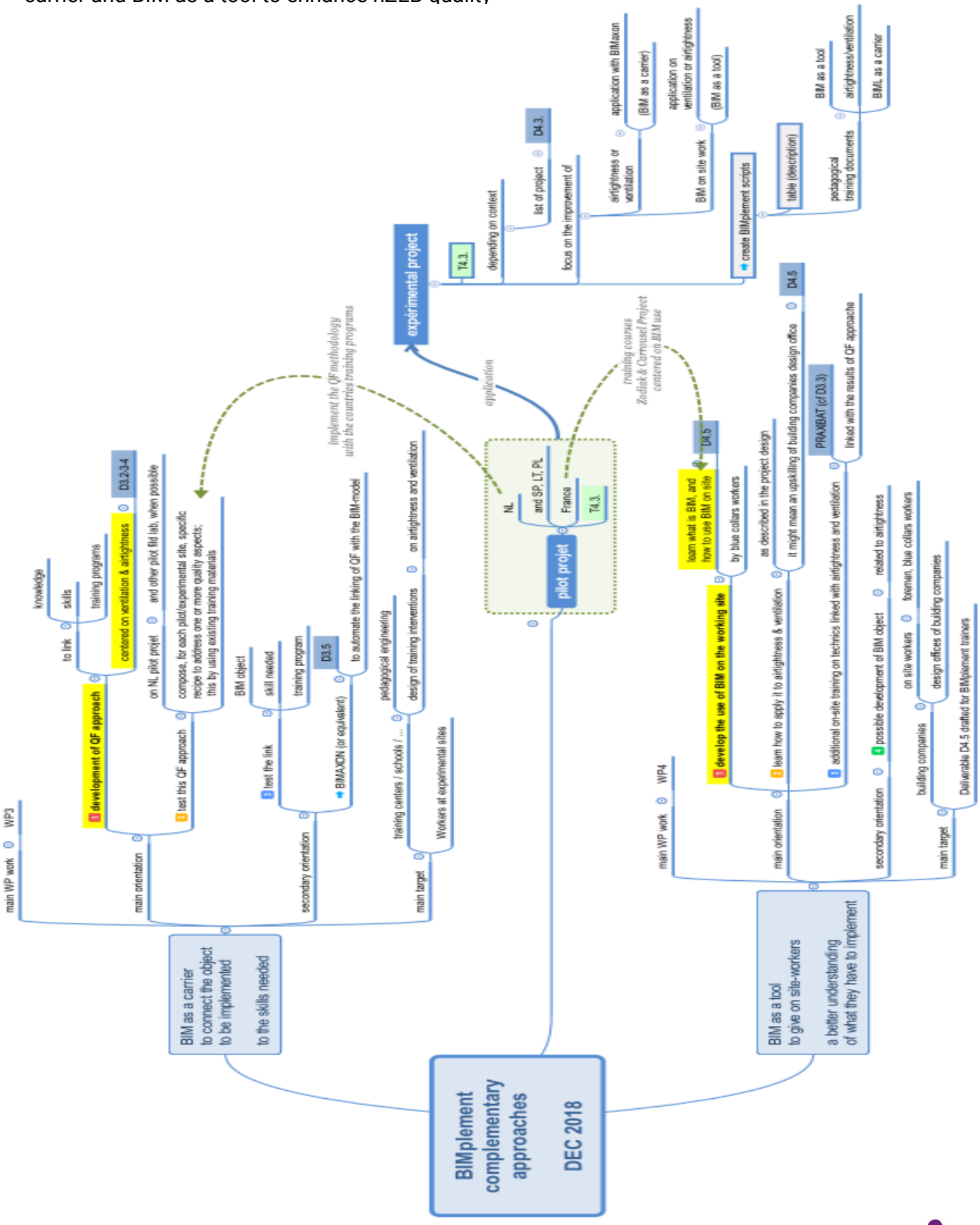





accompagner la montée en compétence
--> WP2-WP3 (Qualfication framework)
when
quand
design phase
phase design
project manager
maitrise d'oeuvre
execution phase
phase EXE
companies' design offices
BE des entreprises
who
qui
design offices
bureaux d'études
of the project manager and of the building companies
du MOe et des entreprises
foremen
µchefs de chantier
what
quoi
check/improve the workers'skills
vérifier/améliorer les compétences des intervenants
design offices engineers and techniciens
ingénieurs et techniciens des BE
foremen and blue collar workers
chefs d'équipes et compagnons
how
comment
necessary skills table (QF)
tableau des compétences necessaires pour chaque tâche (QF)
design phase
phase conception
execution phase
phase réalisation
link with the training content table (knowledge)
mise en lien avec tableau des formations (connaissances)
mapping with the BIM objects that needs these skills and knowledge
mise en correspondance avec les objets BIM qui nécessitent ces compétences
BIMAXON
BIM object "classification"
"classification" des objets BIM

17. Annex 6 : BIMplement approaches on BIM

Mind Map 3 : presentation of the 2 complementary BIMplement approaches on BIM : BIM as a carrier and BIM as a tool to enhance nZEB quality



COLOFON

BIMplement

This project has received funding from the European Union's h2020 framework programme for research and innovation under grant agreement no 745510

The information in this publication does not necessarily represent the view of the European Commission.