



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:	D3.4 Selected tools and learning methods, implemented in the five national frameworks
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Table of changes

Version 1	January 31, 2018	First version
Version 1.1	February 19, 2020	Added some additional relevant functionalities for BIM tools e.g. rule checking in Solibri. Added research question about using a property set for air tightness A summary table of tools and methods per country

1. Introduction

This report represents an inventory of (BIM) **tools and learning methods** that can be used to implement the qualification connected content on training, exercises and other relevant material.

The selections were made during a task called “Implementing into learning tools and learning methods by connecting them to the BIM models & process.” Afterwards the results will be there where possible and relevant integrated in BIM models and processes, i.e., BIM used as a carrier of information of skills, trainings and tools for (in this case) the selected topics ventilation and infiltration. If possible the actual software implementation within the selected tools and learning methods will be performed. This can include for example connecting databases with learning content to the BIM-model(s) and the selected learning tools.

These will be input for the experimental sites where they will be used for the task “Configuring tools, learning methods, and qualification schemes” fit for use on the experimental sites. Thereafter the tools, the learning methods and the qualification schemes will be connected to the projects defined in the pilot field labs and the experimental sites, this in order to improve the quality of the involved white and blue collarworkers and thus, improving the overall quality of the construction process.

Based on the project needs, the level of BIM implementation and the nZEB-challenges in the selected projects scripts for successful implementation of the developed means will be written, discussed and implemented. Based on 50 projects this will lead to an inventory of BIMplementation scripts, including experiences with these scripts. These scripts will be part of the BIMplement guide.

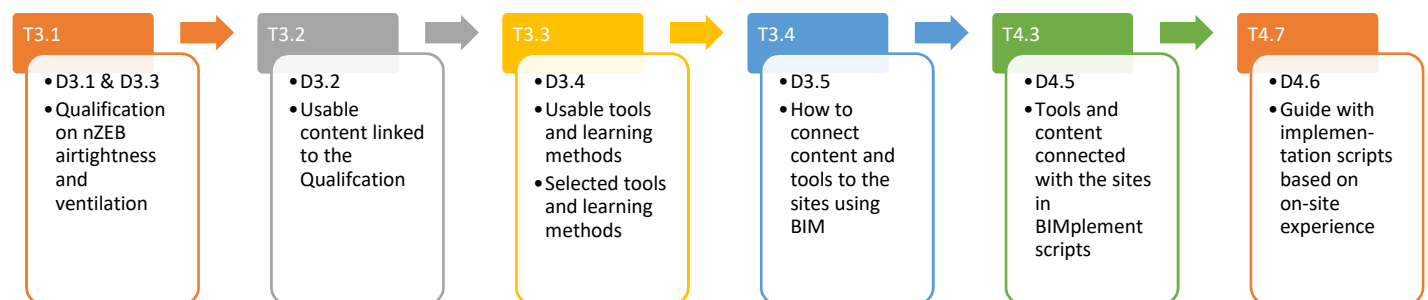


Figure 1: From Qualification -to- a tool selection -to- implemented tools -to- usable implementation scripts

2. Setup of this deliverable

Within BIMplement existing (BIM) Learning Tools and learning methods will be applied to enable professionals and workers to:

- Upskill themselves just-in-time and just-in-place
- Create learning loops in projects and between projects
- Create moments for cross-trade 'clash-moments' / 'Action Learning'

In this deliverable each involved country made an inventory of available (BIM) learning tools and learning methods. After that a pre-selection is made and experiments are described that are needed to validate the usability (in the pilot fieldlabs). In Task 4.3 this selection in dialogue with the experimental sites is made and documented.

In the following chapters each involved country first provided an inventory of available learning tools (name of the tool, possible use and one or more screenshots).

For each country a summarizing overview table with learning tools and methods is given.

Type	Inventory of learning tools and learning methods [Country name]
Learning tool	
Learning method	

Table 1 : Format of the summary table for the inventory of learning tools and learning methods

Real application at experimental sites will be part of workpackage 4. In Deliverable D4.6 the output of those experiments will be reported in a common reporting scheme.

3. Results from France

3.1 Inventory of available tools and learning methods

Key issues regarding training in France for blue collar workers in relation to airtightness and ventilation.

Cross craft cooperation and coordination at the workplace is a must have to achieve good airtightness and ventilation. Craftsmen and blue collar workers are not used to this cooperation/coordination. SMEs and their workers have a strong reluctance towards training: 'they think that they know it all, and that they do not need to learn' If the training is compulsory, they prefer « hands on » practice, rather than Power Point presentations and theory.

Tools and methods that fit the needs of blue collar workers.

PRAXIBAT

It is a training tool used for increasing the competencies regarding airtightness and ventilation. This tool is a « platform » that includes all the necessary materials to do a « hands-on cross-craft » training. (see below). There are today 117 PRAXIBAT platforms in France, most of them being located in technical schools. They are mostly used to train apprentices and students : SMEs do not use them.



01Example of a Praxibat platform

FIT 2.0 : Formation Intégrée au Travail = « training at the workplace »

FIT 2.0 combines a **mobile PRAXIBAT platform** which comes to the workplace, and **pedagogical mock-up** (including one for airtightness and one for ventilation) – see below).

The trainings take place during the working hours and are compulsory.

This methodology is experimented in the north of France since June 2018. It is quite successful.

The platform is placed in a sea container (see photos below). It is a « practible » cell that concentrates the « hot points » of a building, and fits the needs of the various crafts. It makes it possible to work with various type of materials (wood, brick, agglomerat ...)

The trainees are blue and white collar workers, who are working at the workplace.



02 Photo collection of the Mobile FIT2.0 platform

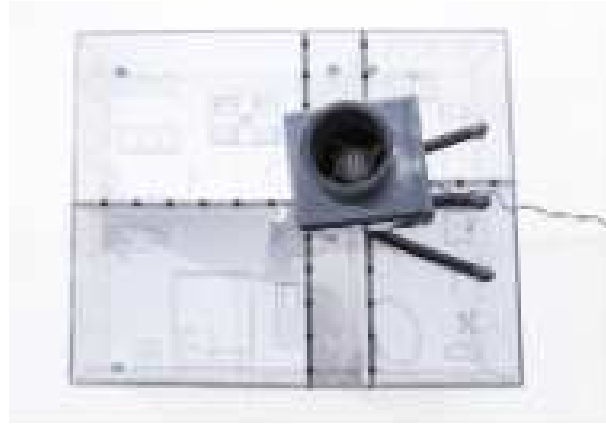
The mock-up

There are various type of mock-up. The most commonly used are the « house » and the « ventilation tool ».

The « house » This mock-up shows the air tightness problems (the leaks), with a white smoke that is put into the mock-up.



Ventilation



03 The ventilation mockup

The mock-up shows a house with a bathroom, a kitchen, and two living rooms. It demonstrates the impact of airtightness on a mechanical ventilation. The movement of the air between the room is visible thanks to smoke that is blown into the mock-up.

3.2 Inventory of available tools and learning methods – BIM approach

As presented in §3.1, an important effort has been implemented in France in order to give practical and pedagogical tools for airtightness and ventilation implementation. Other deliverables also give a certain amount of references and regulatory document for airtightness and ventilation design, implementation and quality control.

In terms of BIM, French building companies are a bit late in terms of BIM use, both at the management and design level (within the building company), and even more at the worksite level, where almost no foremen, and all the more blue collar workers, open and use BIM models.

a) BIM training for building companies

ASTUS has designed and implemented several type of training sessions directed toward small and medium building companies and craftsmen.

Two levels have to be trained :

- 1) the company manager, the project manager, including design office, and the on-site foremen
- 2) on-site team manager and blue collar workers

Even if the content level and complexity is not the same for both groups, some parts of the training program are based on the same elements :

- convince the stakeholders of the interest of BIM
- explain what is a BIM process, what what are the impacts on every days work
- teach how to use different viewers for quality improvement, for instance ventilation and airtightness

In addition manager will be explained :

- what tools should be used to answer the project BIM requirements
- how to collect and export datas, control the work done, realize an as-built model
- organize the company and the project team to realize the project in the best conditions

Examples of training programs realized during the BIMplement project will be given in D_4.5 .

b) tools for BIM use in building companies

Two levels of BIM development of the companies can be identified. Each will need a different set of tools.

b.1) companies that will probably never develop its own technical BIM models

These companies, embedded in a project where a BIM process is required, will need to be able to open BIM models with the help of freeware viewers. They will get the BIM models from the project manager (architect and design offices).

Here below are presented a few viewers :

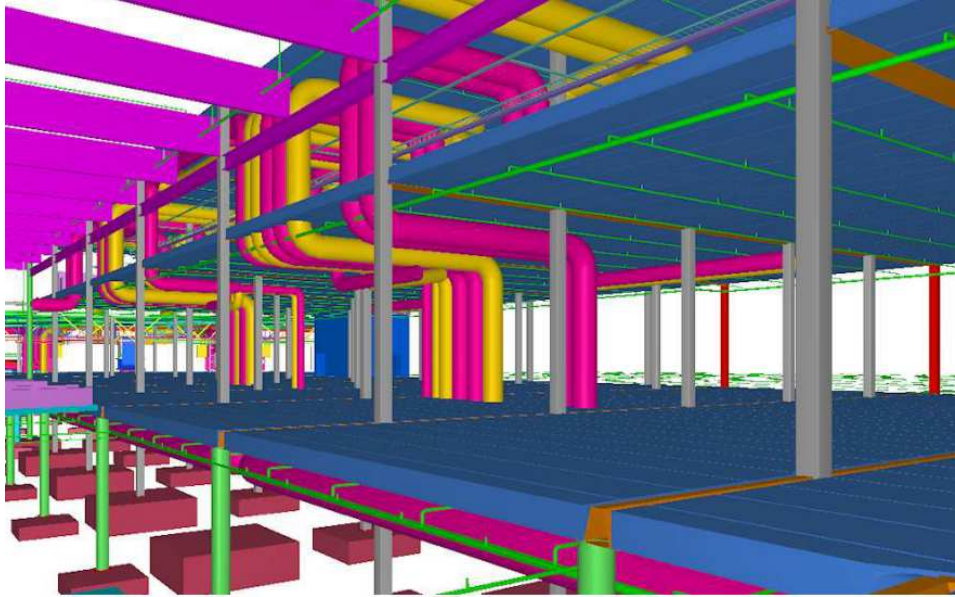
Solibri Model Viewer : <https://www.solibri.com/products/solibri-model-viewer/>

+ english video : <https://www.youtube.com/watch?v=C7T7PA1jRFM>

SOLIBRI allows to:

- ➔ Open the hierarchies of the ifc, **ONLY ONE model at a time**:
 - By levels: virtually rebuild the building
 - By elements: identify divisions by elements
 - By layers: organization of the native file
- ➔ “Visit” the building to understand it, especially via cuts
- ➔ Locate the information of the different objects

- ➔ Rule checking
- ➔ Use "communication" for remarks from and for a BIM Manager who uses "Solibri Model Checker" (notes, comments, sketches ...) and E_mail them



TEKLA BIM SIGHT <http://www.teklabimsight.com/download>

+ a whole set of english videos : <https://helpcenter.teklabimsight.com/helpcenter/takeATour.jsp>

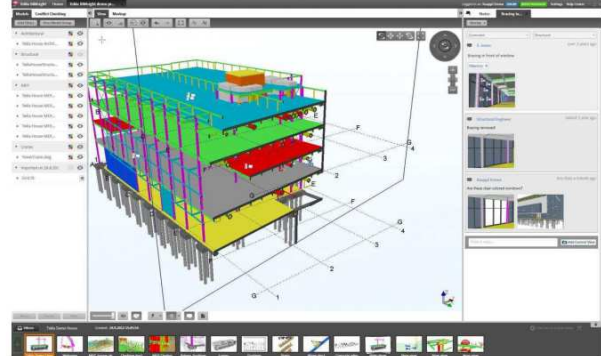
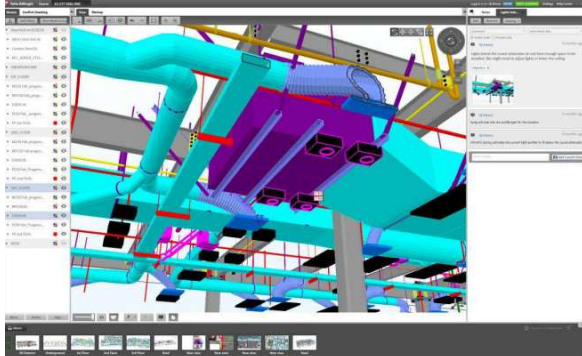
Tekla Bim Sight allows you to:

- ➔ Open several BIM models in the same time
- ➔ Verification of georeferencing with the grid
- ➔ detect collisions between models
- ➔ Use "memos & notes" to communicate

notes

BFC documents

- ➔ Link documents to the objects of the model and make comments

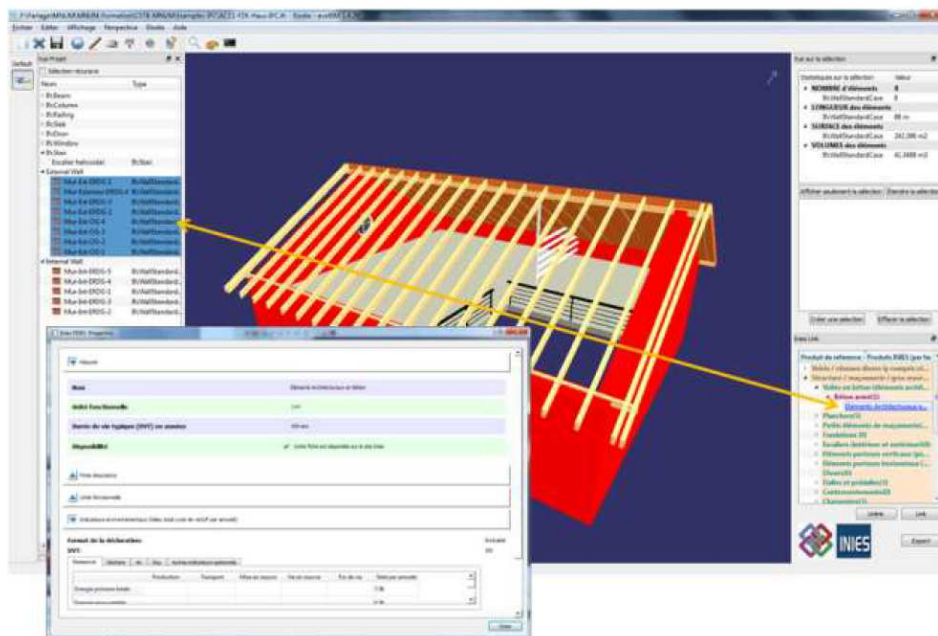


EVE BIM : <http://editions.cstb.fr/Products/eveBIM-Viewer.html>

EVE BIM makes it possible to

- synthesize models -Rename elements for better understanding
- Save changes to a new IFC

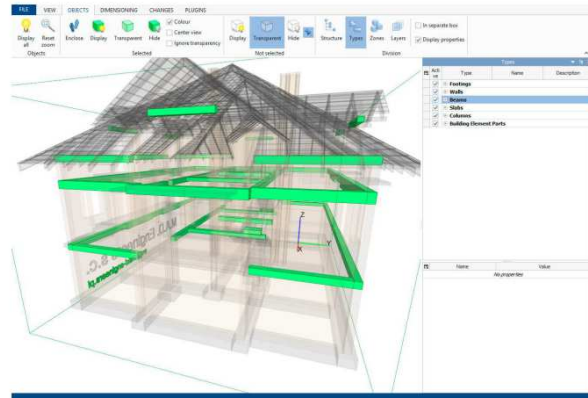
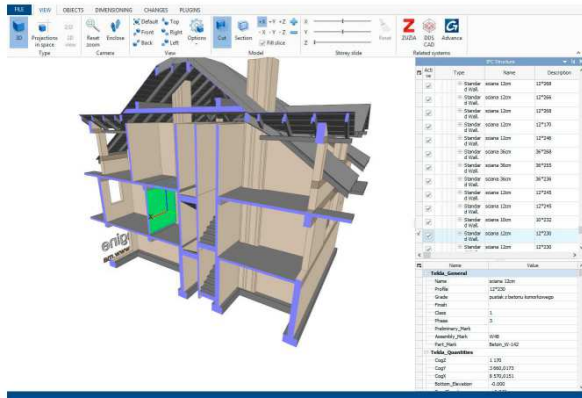
EveBIM



BIM vision : <http://bimvision.eu/en/download/>)

- quantify a series of BIM objects

Bimvision

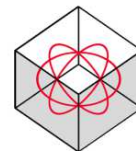


Dds Cad <http://www.dds-cad.net/>

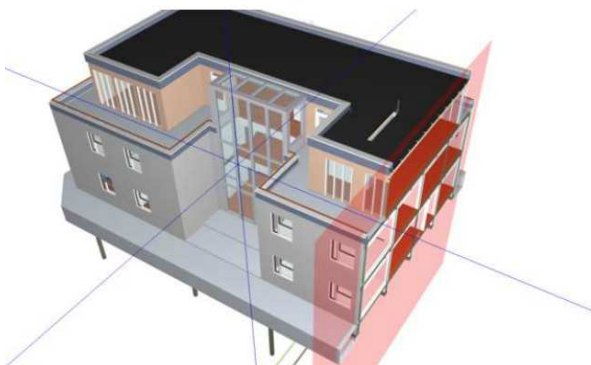
Dds Cad allows you to:

- ➔ combine the models
- ➔ check clashes
- ➔ share information

Dds Cad



DDS-CAD



In addition to freeware viewers, these companies will need to exchange information and collect up-to-date BIM models. Collaborative platforms are an on-line numerical space where a project BIM resources can be collected, exchanged and updated real time. Usually, it includes viewers for the BIM models, and accept BCF comments, memos It may also include different other tools to achieve better collaboration between stakeholders. Here below are presented a few of these free-of-charge collaborative platforms.

A360 platform

The A360 platform allows the use of different files such as IFC, NWD, RVT

This platform includes a viewer. It enables the sharing of BIM models and comments between stakeholders

A360 is also accessible with a tablet (Ipad)



b.2) companies that will probably in the future have to develop its own technical BIM models

These more BIM experimented companies will need to find and extract more information from BIM models than just quantities.

SIMPLEBIM software

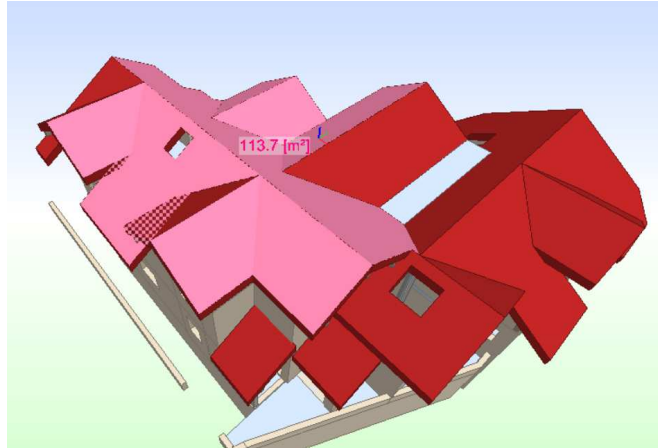
SIMPLEBIM is a professional software that allows the export of the whole set of a BIM model objects data, including their properties.

Here below, an xls table of SIMPLEBIM data export

	A	B	C	N
1	Door			
2				
3	Name	Description	Object type	Fire Rating
4	12.2_Simple (R):83 x 204 - (80):1328979		83 x 204 - (80)	PF1/2H
5	12.2_Simple (R):93 x 204 - (90):1328980		93 x 204 - (90)	PF1/2H
6	12.2_Simple (R):93 x 204 - (90):1328981		93 x 204 - (90)	PF1/2H
7	12.2_Simple (R):93 x 204 - (90):1328982		93 x 204 - (90)	PF1/2H
8	12.2_Simple (R):93 x 204 - (90):1328983		93 x 204 - (90)	PF1/2H
9	12.2_Tiercé (R):143 x 204 - (140):1328991		143 x 204 - (140)	
10	12.2_Tiercé (R):143 x 204 - (140):1329000		143 x 204 - (140)	
11	porte sans bati:porte sans bati 500:1329014		porte sans bati 500	
12	porte sans bati:porte sans bati 500:1329015		porte sans bati 500	
13	porte sans bati:porte sans bati 500:1329021		porte sans bati 500	
14	porte sans bati:porte sans bati 500:1329022		porte sans bati 500	
15	Simple vitrée-sans dormants:simple:1491285		simple	
16	Simple vitrée-sans dormants:simple:1486694		simple	

BIMVISION viewer

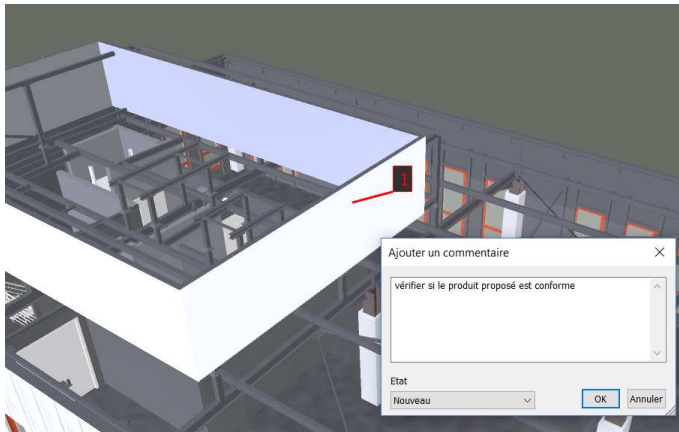
This viewer can give a measure or a quantity, while just clicking on different objects.
For example, here below, roofing area calculated with BIMVISION



NAVISWORKS Freedom viewer

Navisworks Freedom allows you to :

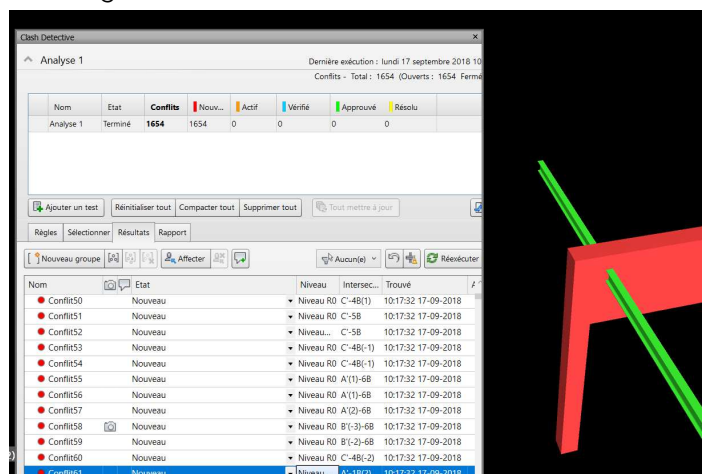
- view the BIM models
- draft comments



- link documents to objects

In addition, Navisworks Freedom allows the BIM manager to

- ➔ check conflicts between several models
for instance to check the good position
of blokout
- ➔ build up a 4D planning



b.3) companies that already develop their own technical BIM models

The design offices of these companies usually already develop their own trade BIM models.

However, they often do not design them for a future use on site.

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 ou ALLPLAN
 - ➔ the HVAC technical design office realize 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 ?
- ➔ present different example of structure or MEP model to understand what can be expected of this trade model, and apply this process, for instance, 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.

The development of a BIM culture within the company will allow and improve exchanges between management offices and site-work.

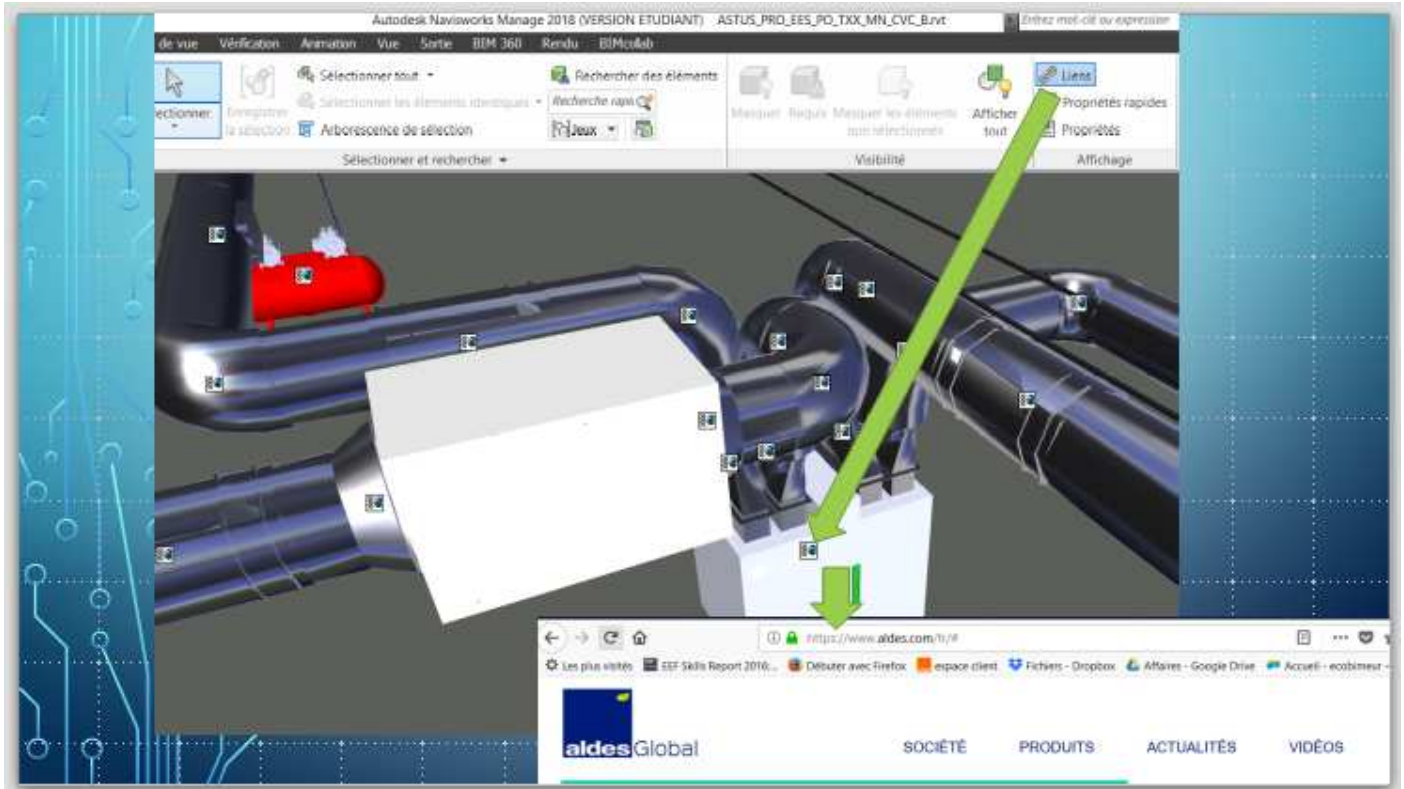
c) improving BIM models

Ventilation systems are already very well documented, and there already exist quite a large amount of BIM object to describe each elements of this system.

The main issues with ventilation are :

- check the potential conflicts with structure and roofing (see previous §)
- take into account the impact of these elements on the building airtightness.

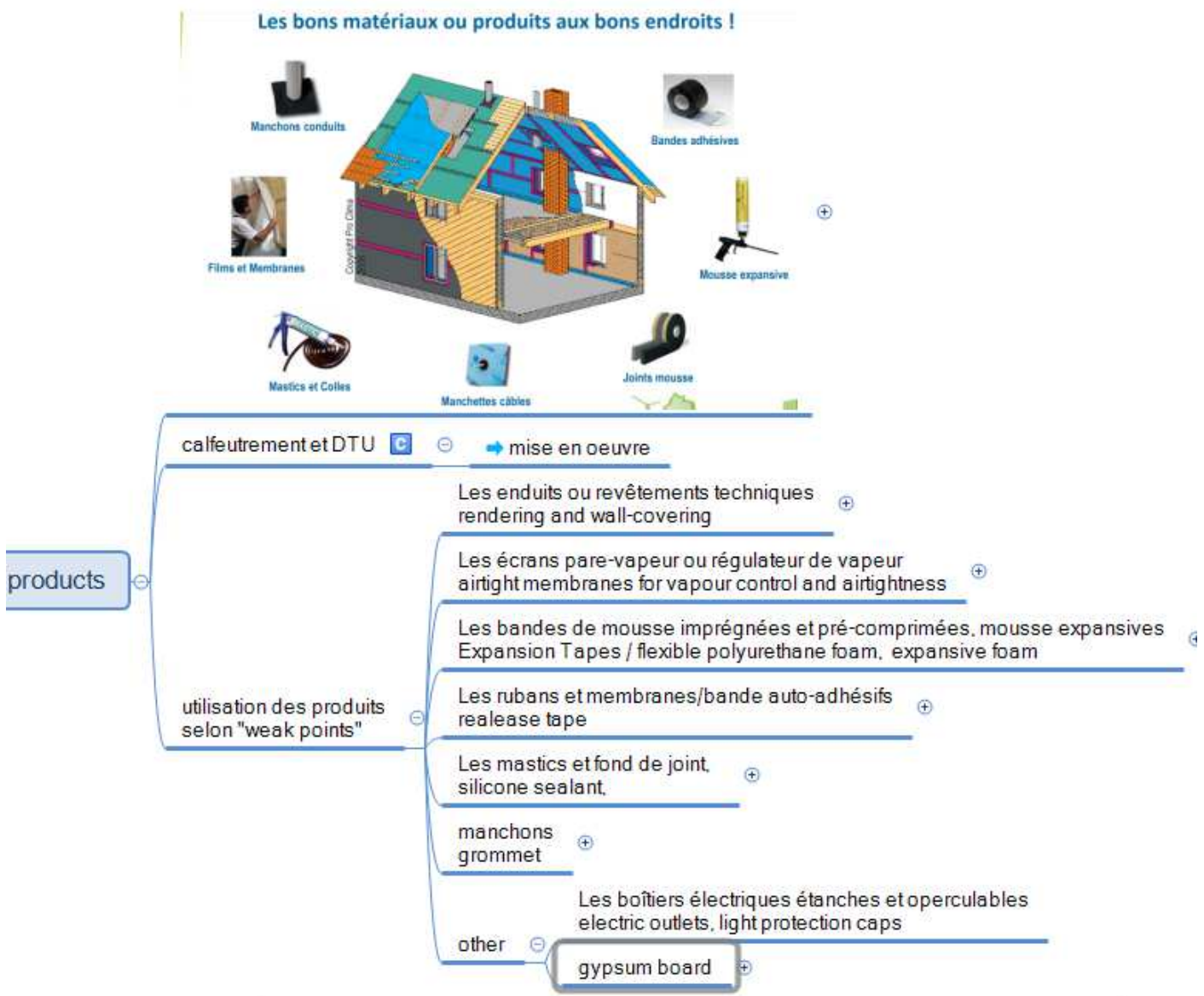
An extensive use of attached notes and documents in the BIM models, as well as a better use of BIM models by the foremen and Blue collars should help a lot in a better site implementation.



Addressing airtightness in BIM

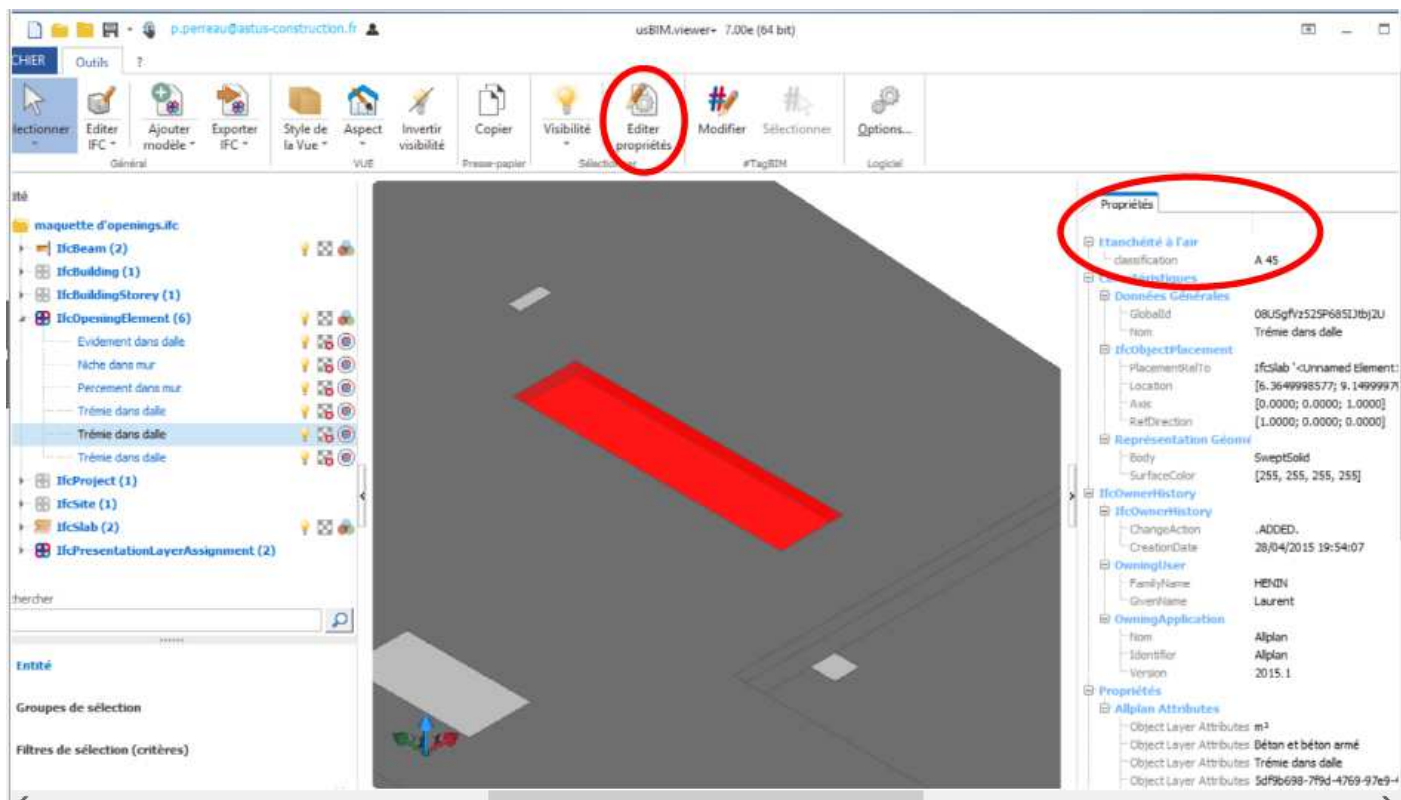
As for airtightness, the issue is very different.

On one hand, all trades are concerned with this question, not just a few with ventilation. On the second hand, there does not exist, up to now, any BIM object that describes the product used for airtightness. This means that a BIM model cannot include the specific product compulsory for a good airtightness.



However, there is a very little used BIM object, called "IfcOpeningElement", that could be used to concentrate all information related to each opening, be it a window in a wall, a pipe through a roof, an electrical wire through an airtightness membrane ...

During the BIMplement project, experiments will be done to check the conditions under which these special BIM objects could be used. Also the research question about the possibility of using a property set for air tightness will be answered.



3.3 Overview of learning tools and learning methods in France

Type	Inventory of learning tools and learning methods in France	
Learning tool	Solibri Model Viewer	
	TEKLA BIM SIGHT	
	EVE BIM	
	BIM vision	
	Dds Cad	
	A360 platform	
	SIMPLEBIM software	
	BIMVISION viewer	
	NAVISWORKS Freedom viewer	
Learning method	PRAXIBAT FIT 2.0 Mobile container	
	Mock-up models for ventilation and airtightness	
	Addressing airtightness in BIM	

Table 2 : Summary table for the inventory of learning tools and learning methods in France

4. Results from The Netherlands

4.1 Inventory of available tools and learning methods

In line with the process described below, there are several learning methods (and the respective tools) in the Netherlands which can be used.

Awareness

Before delivering the appropriate information to the workers, there has to be a common ground in BIM and nZEB knowledge and skills. To attain this common ground, there are a few learning methods:

1. Get a basic understanding of BIM

Not all workers have a common understanding of the basics of BIM. To help them get to the same basic level, there are a few tools available:

- BIM Awareness training

One of the deliverables of the EU-project Net-UBIEP is an awareness training for workers. This awareness training will be a short e-learning module and a classroom variant.

- Book "Starting with a BIM" (ISSO publication 109)



Front cover of ISSO publication 109 Source: ISSO

The ISSO publication describes the basics of BIM as well as the steps needed to take as an organization to work with BIM.

- Instruction videos (Youtube, i.a.)

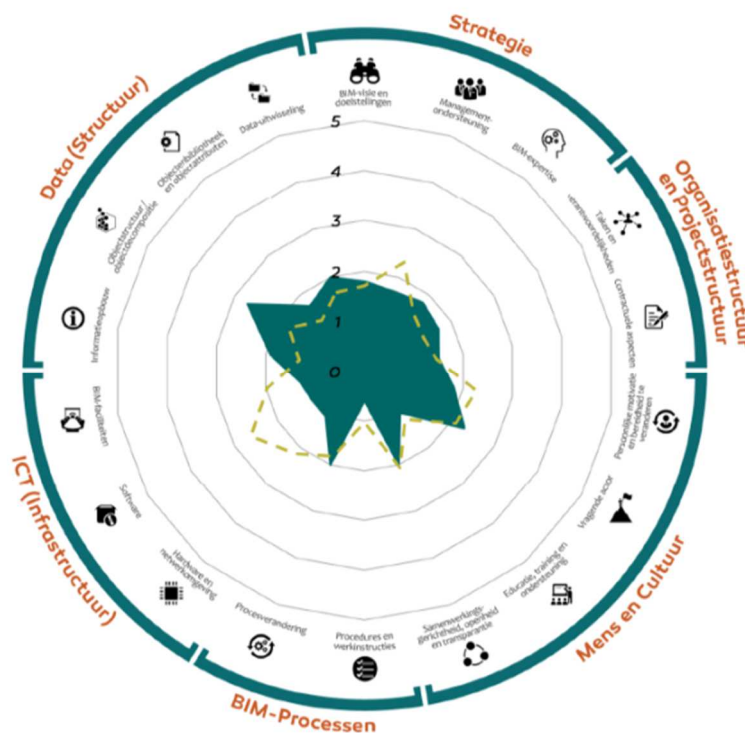
There are a lot of instruction videos on internet which help workers understand the basics of BIM

2. Obtain insight in current BIM qualifications

It is not uncommon for workers to have certain qualifications in relation to BIM, without them knowing it (p.e. knowing how to read 3D drawings from a PDF-file). Knowledge of current BIM qualifications can help workers (and organizations) in formulating their need for additional qualifications. The tools for obtaining insights are:

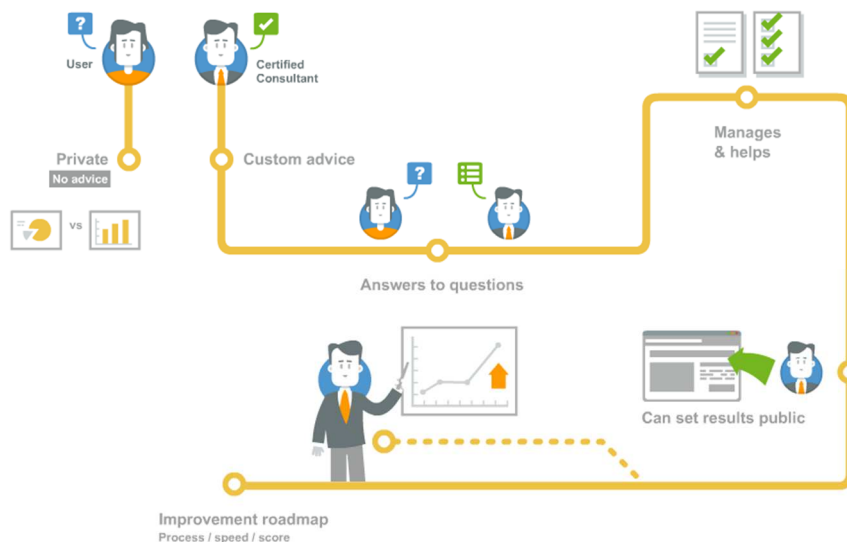
- BIM Maturity test (for organizations)

In the Netherlands there are two (scientifically) validated models for organization to test their BIM maturity. The University of Twente (UT) uses a model based on the work of Penn State University and TNO (Dutch research institute) has developed their own maturity model (<https://bimsupporters.com> in English).



Results of UT maturity scan

Source: Bouw Informatie Raad



Process of TNO quick scan

Source: BIMSsupporters

- BIM competency test (for individuals)

There are a few organizations in the Netherlands that provide assessments on BIM qualifications. They match international qualification standards with BIM specific roles and qualifications.

Competentieprofiel: BIM coördinator ANNO1809

Verticale as: Mate van ontwikkeling van de competenties
Gebaseerd op: Feedback van Centrale persoon (zelf) d.d. 20-03-2018

Horizontale as: Mate van aanleg / ontwikkelbaarheid van de competenties
Gebaseerd op: TMA Talentanalyse van

ANNO1809
Explore your BIM Skills

Goed ontwikkeld	Visie	Kwaliteitsgerichtheid	
	Creativiteit	Samenwerken	Discipline
Voldoende ontwikkeld			
Matig ontwikkeld	Leidinggeven Oordeelsvorming Overtuigingskracht	Coachen Organisatieactiviteit	Plannen en organiseren
		Initiatief Omgevingsbewustzijn	
Zwak tot onvoldoende ontwikkeld			
	RISICO'S BEHEERSEN	BENUTTEN & VERSTERKEN	
	OMHEEN MANAGEN	INVESTEREN & ONTWIKKELEN	
	Weinig aanleg / moeilijk ontwikkelbaar	Enige aanleg / redelijk ontwikkelbaar	Veel aanleg / makkelijk ontwikkelbaar

Voor onderstaande competenties kan geen aanleg / ontwikkelbaarheid worden bepaald op basis van de drijfveren.

- Probleemanalyse
- Schriftelijke vaardigheid

Example of BIM competency test method

Source: ANNO1809

3. Get a basic understanding of nZEB

Not all workers have a common understanding of the basics of nZEB. To help them get to the same basic level, there are a few tools available:

- E-learning modules (in Dutch) on airtightness and ventilation in the (BUILD UP Skills advisor-app)

Luchtdichtheid: Problemen en oplossingen

Stopcontacten zijn soms lastig luchtdicht te maken. In de afbeelding is te zien dat rond het stopcontact warmte verloren gaat, hier is duidelijk een luchtlek aanwezig. Luchtdichte inbouwdozen kunnen luchtlekken voorkomen.



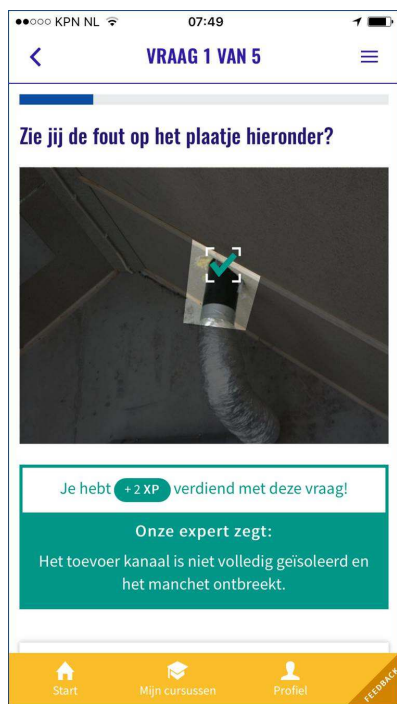

Example from the e-learning on airtightness for installers

Source: ISSO, the H2020 BUSToB project

4. Obtain insight in current nZEB qualifications

In line with getting insight in the current BIM qualifications, workers can get insight in their current nZEB qualifications. The tools for obtaining nZEB insight are:

- Learning from Building errors (BUILD UP Skills advisor-app)
An example with the Dutch versions and Dutch content. The BUS-app is also available in English and Spanish, content can be made in English too.

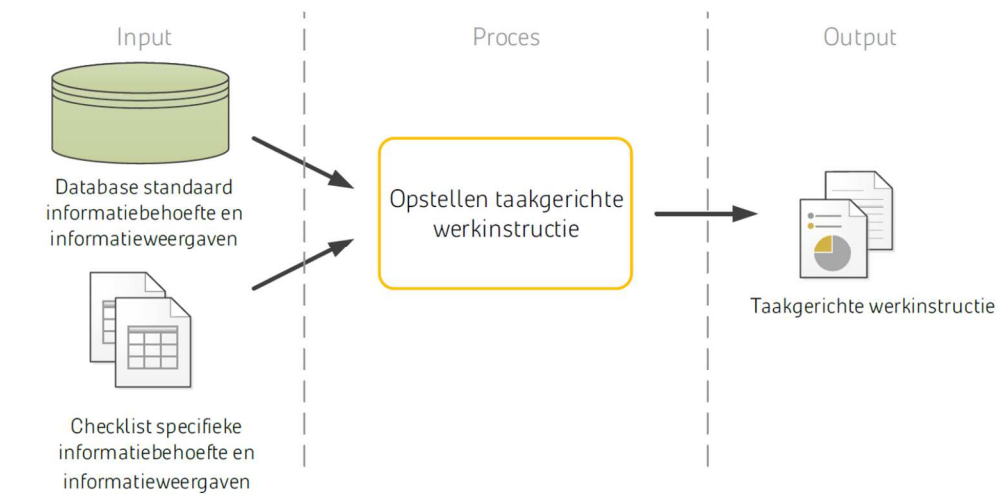


BUS advisor app

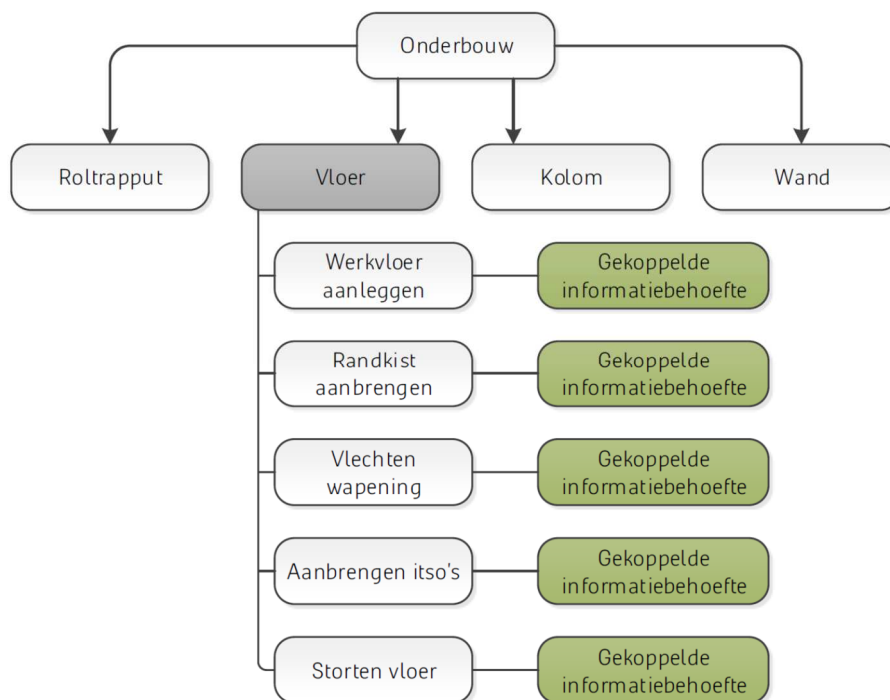
Source: ISSO

Preparation

In order to help blue collar workers in getting the right information at the right time, the project organization needs to have a clear understanding of the project tasks and information need related to the tasks. This can be represented in a **task-information diagram** and can be obtained through analysis of the contractors process and through dialogue with workers.



Source: Span, T. Masterthesis Creation of task based workinstructions



Source: Span, T. Masterthesis Coupled informationneeds with tasks

If/when the above is clear, the individual workers need to prepare for the execution of the project tasks. In general, they might need to practice and to improve (missing skills). The learning methods that support this are:

1. **Obtain insight** in project specific qualifications (BIM and non-BIM)

The execution of project tasks requires certain qualifications of the worker. These project specific qualifications can be derived from (inter)national or company specific frameworks:

- (D3.3 input)
The qualification framework as described in D3.3 of BIMplement can be used as input
- Syllabus
Some sector institutions use syllabi to describe qualifications related to tasks, roles and functions



Standard syllabus of the Dutch Architects

Source: BNA

- BIM Trivia
Another tool for obtaining insight is via gamebased instruction



BIM Trivia board game

Source: BIMpuls

- BUS Advisor app (BUILD UP Skills)
The BUS advisor app can be used to get insight in which qualifications are needed for certain roles/functions.

2. Attain missing competences (BIM and nZEB related)

When there is a gap between current and needed competencies, workers need to attain the missing competencies. There are a few tools to help them:

- Training

There are multiple possibilities for training specific qualifications, BIM as well as nZEB

- E-learning

There are multiple possibilities for e-learning specific qualifications, BIM as well as nZEB

- Virtual Reality

Virtual Reality (VR) is the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors. The worker can use VR in training simulation to get more skilled in a certain task or when a project task is complex a/o time sensitive. This is not yet common work practice, but there are already a few successful experiments. Workers need extra training for using VR effectively.

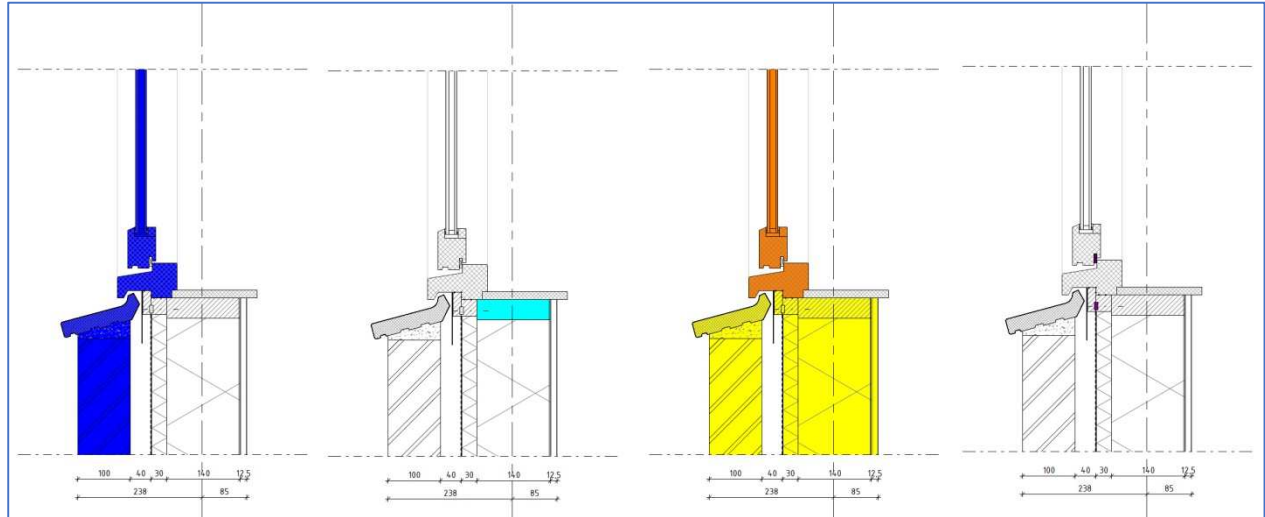


Example of VR

Source: Duurzaam Gebouwd

A second prerequisite is that the needed information is present and available in the BIM model. This is called information quality and can be represented through a **checklist**. Examples of information to be found in a BIM (or added to it):

- Basic object information a/o properties (as described in an IDM)
- Additional product information (i.e. from vendors)
- Interface information (e.g. ISSO reference details)

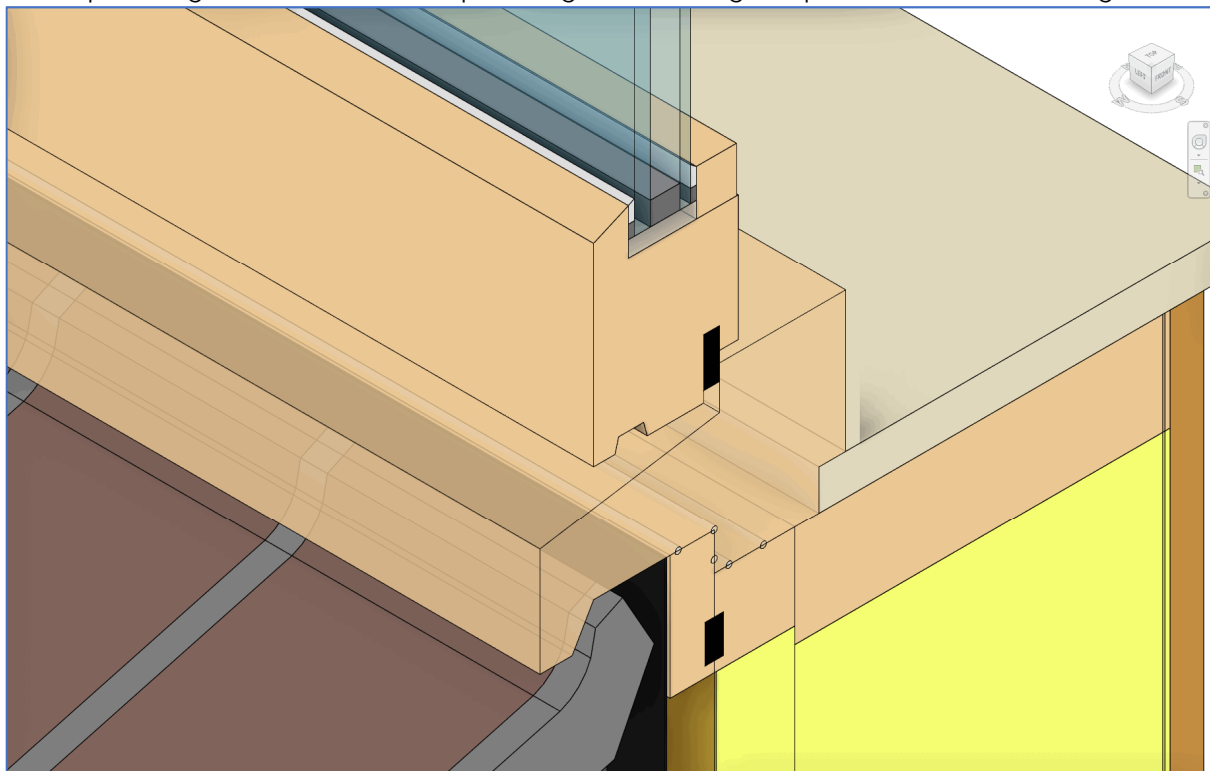


Waterproofing

Moistproofing

Energetic prestation

Airtightness



Showing more details of the model

- 4D planning information
- Other information from the task-information diagram

If the information is not in a BIM model, then it should be stored in a central database. This information can be used by workers in addition to their task development. There are a few working methods that support this:

3. Practice complex situations a/o improve skills

For the workers who are up to speed with their qualifications, but want to get more insight (i.e. information), there are tools also:

- Virtual Reality (VR)

VR can be used to digitally simulate certain tasks.

- Simulations

With the simulation of real-life situations workers can gain insight in their project specific tasks



Blower door simulation

Source: RAAK energie

- Mock-ups

By using mockups of certain parts of the building workers can see how these parts are constructed and what is needed for the execution of the task.



Mockup façade for airtightness test

Source: architectenweb

4. Consult colleagues

Colleagues are often a great base of knowledge on how to approach a project specific task and to explain specific situations, approaches and details. They can help out with:

- View of BIM model

Blue collar workers are not the people who actually build the models, but only use the information inclosed in them. Viewing models is quite intuitive and most companies have people with digital skills and interests. They often help out their colleagues with viewing the BIM model or teaching them to do that themselves.

- Practical knowledge and experience

By reviewing project specific documentation the workers get a better grasp at the tasks at hand and the circumstances/constraints in which they perform their tasks

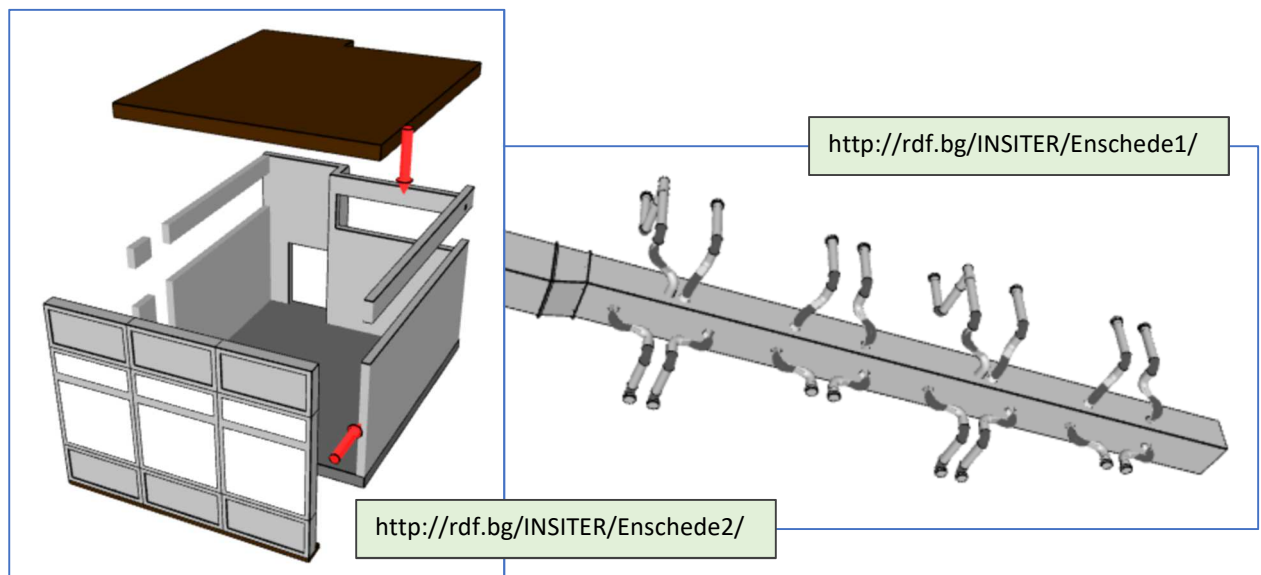
Execution

In the execution of the project workers can get on the job support which is related to their task or to the information they need to perform the task. The latter is mostly BIM based.

1. Get on the job support (task)

The taskrelated on the job support is based on the qualification framework

- Step-by-step task instruction



2 examples of step by step instruction images based on IFC

Source: H2020 INSITER

- Videos
Instructive videos on how to perform a task (can be linked to BIM if necessary) can help workers improve the quality of their work.
- Apprentice–Journeyman–Master-system
Especially older employees have tonnes of experience from working on similar projects with similar tasks. They help out younger colleagues with instructing them in viable solutions and teaching them their lessons learned. More and more companies are re-introducing a system in which knowledge and experience is systematically transferred in practice situations.
- On the job training
There are several training institution who offer on the job training for specific tasks/roles.

2. Get on the job support (information)

The available information needs to be given to the workers at the appropriate time (related to the tasks/schedule). There are a few tools to deliver the information:

- Use of **aspect models** (by using modelling software)

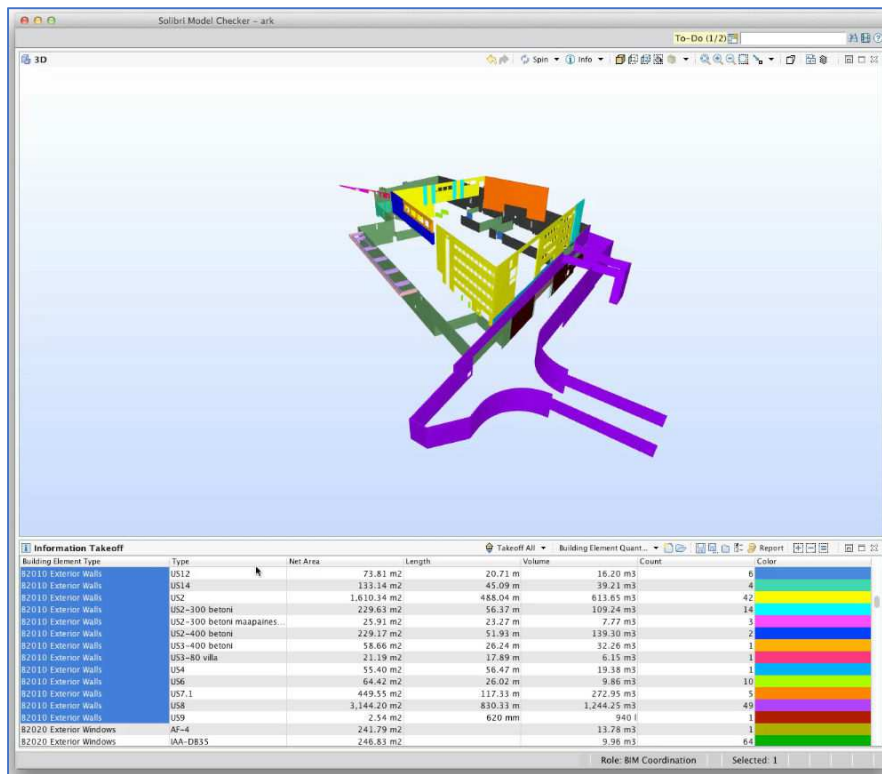
This is a model where only the information is shown that is relevant to a certain user. For instance: a model that only shows ventilation ducts and the interfaces with the walls and other installations can be considered an aspect model. It should be presented at the start of the activities of the given user as it is mainly handy to give an overall view of the project. Later on it should be available when requested. The worker needs only be able to view the model and can use model viewers for that.



Example of an aspect model Source: Installatiejournaal

- Use of **information take-off** (by using coordination software)

An information take-off is a certain set of objects for a specific use. For instance: a set of objects related to the assembly of a window (frame, glass, etc.), but also the interface with the wall (e.g. anchors, finish, insulation, brick). This can be generated in alignment with the planning, so the worker gets detailed information for the task at hand. The worker can get this as a 2D/3D view on paper or via viewing software, but also as quantities in an Excel sheet or on paper.

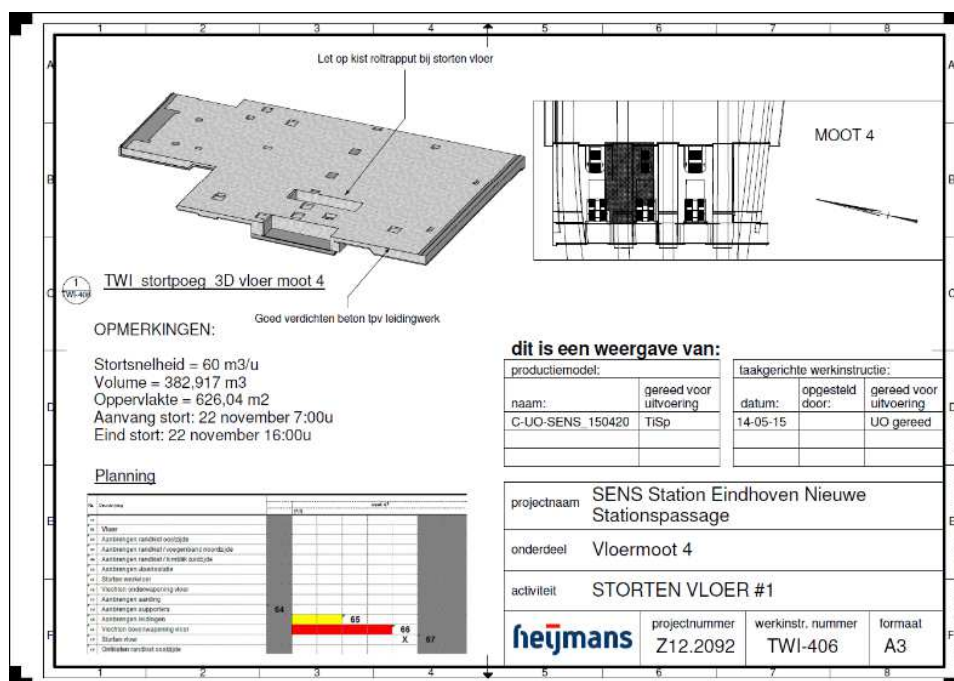


Example of an information take-off

Source: CADeshack

- Use of task based work instructions

When using taskbased work instructions, every task will have projectspecific information added to it, coming directly from BIM. Thus, a complete manual of work instructions is generated for the worker. Generally, taskbased work instructions (if available) comprise task descriptions, 2D/3D drawings, additional product information from the vendor(s) and reference details. The worker can get this 'manual' via daily PDFs or on paper.

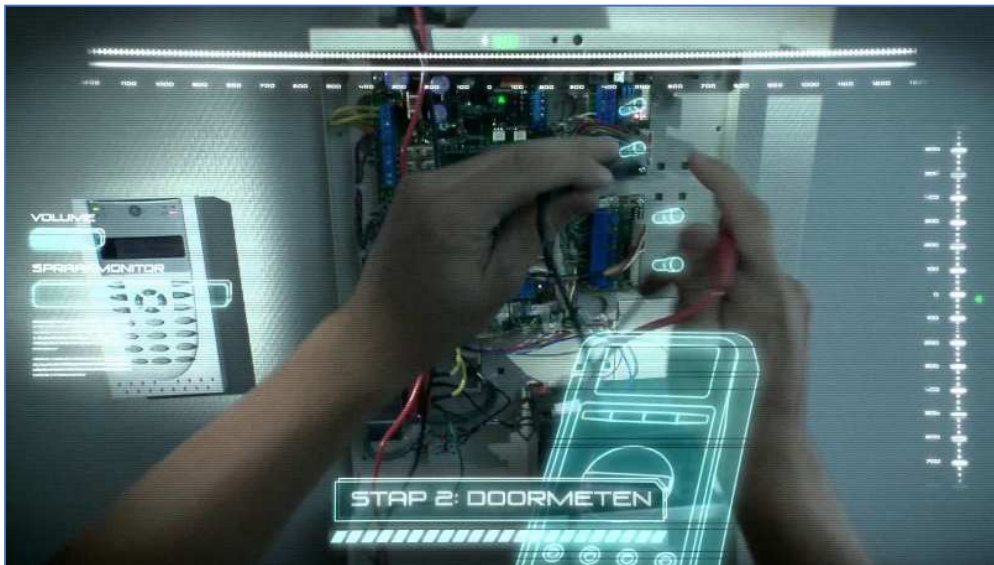


- Use of **task information management** (*in development*)

Task information management is basically a dynamic form of task based work instructions, where updates are instant and where user feedback is possible. It requires a certain level of BIM skills from the workers and also the use of digital tools, such as tablets a/o AR/VR. The feedback data is used to create better and faster as-built plans and also support project evaluation.

- Use of **Augmented Reality**

With Augmented Reality (AR) the user wears glasses or uses a mobile device (phone/tablet) to receive extra information as an overlay to what he sees in the real world. This extra information can be of all sorts: a visualization of how a building part will look when finished, or additional assembly instructions, or a check if a task is done, etc. This is not yet common work practice, but there are already a few successful experiments. Workers need extra training for using AR effectively.



Example of an AR mockup

Source: UNETO-VNI

Toolbox meeting

Toolbox meetings are short, periodic meetings where the workers are instructed on H&S aspects of the workplace. Just after these meetings, BIM-related instructions can be given also.

Feedback and evaluation

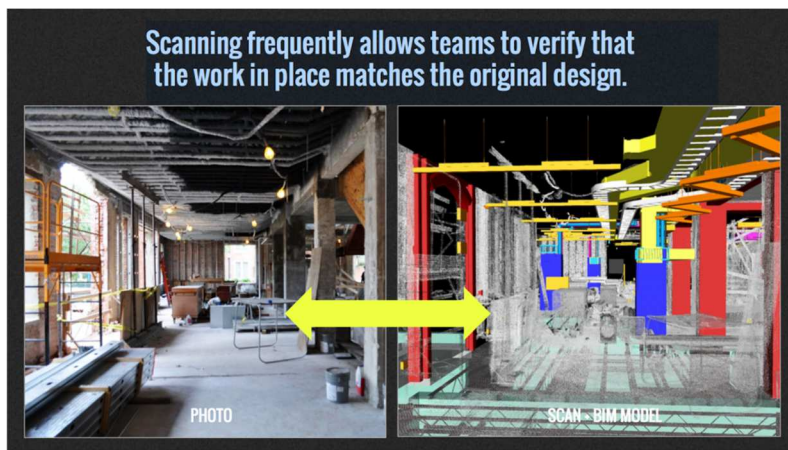
When a task, phase a/o project has finished, it needs to be evaluated/tested for quality and learning purposes. This is not yet common practice, but with the use of BIM, this gets easier. Workers can learn by:

1. Inspection and **quality control**

Quality control and assurance requires that information and product are validated and verified. For this, there are tools at hand:

- Augmented Reality

Workers can use AR to determine differences between planned/designed and constructed elements. They can also use it to measure progress and detect deviations.



AR for verification

Source: eBIM

- Checklists

Checklists can aid workers in a structured way to assess their work and deliver proof

Voortgang

1 Is er een bodemplaat aanwezig?

☒ Ja
☐ Nee

Vorige stap Volgende stap

Example of a checklist in Dutch

Source: kennisbank.isso.nl

- Collaboration software for up-to-date model information

Workers can use up-to-date BIM-information to inspect the work and deliver proof of quality back to the BIM (i.e. mainly to the collaboration software where the quality information is linked to the BIM).

- Coordination software for as built information

Often the work as-built is different than the work as-designed and often the as-built information doesn't depict the real situation. With BIM it's easier to add the up-to-date information, thus creating more reliable as-built information.

2. Plan learning moments

When the BIM is provided with 4D planning properties, workers can get insight in the project planning. With this insight they can more easily plan their own learning moments.

- Planning software
4D planning software (such as KYP) supports workers in planning learning moments. This makes the planning more flexible and the work more efficient.

3. Evaluate work

Feedback given by workers on information and process can be used to improve their work and update the information flow. The following tools can be used:

- BIM collaboration software
Most BIM objects (once created) are stored in libraries for future re-use. Adding learned lessons from finished (or ongoing) projects to the object libraries prevents future mistakes.
- Project(phase) evaluation methods
Most commonly, evaluations (if done at all) are done with the project team in a short meeting. The project's ups and downs are discussed and learning actions are documented and implemented.

4.2 Selected tools and learning methods in The Netherlands

Type	Inventory of learning tools and learning methods in The Netherlands
Learning tool	Aspect models in modelling software (as is used at the experimental sites)
	information take-off (by using coordination software) (as is used at the experimental sites)
	task based work instructions (as is used at the experimental sites)
	Augmented reality (as is used at the experimental sites)
	4D planning software (as is used at the experimental sites)
Learning method	BIM collaboration software (as is used at the experimental sites)
	ISSO Publication 109
	BIM Maturity test
	BIM competency test
	E-learning modules on Airtightness and ventilation
	Learning from Building errors in the BUILD UP Skills advisor-app
	Task-information diagrams
	BIM Trivia
	Building details
	Checklists

Table 3: Summary table for the inventory of learning tools and learning methods in the Netherlands

5.Results from Poland

5.1 Inventory of available tools and learning methods

Below are shown methods and tools which are used in Poland to check the quality of ventilation and airtightness.

BIM model and coordination

At the beginning of building process it is important to make BIM Execution Plan (BEP) in which will be written every assumptions and arrangements by workers. In this document we have all informations about workers and their competences. Thanks to this we can know what kind of trainings, education programs are required to make our workers more productive and competitive.

One of the main applications of BIM model is that we can coordinate work in design phase already. Thanks to this it is possible to make clash detection in a very quickly way. When clash detection is available it is easy to see each potentially leaky places in model (e.g.: passage of the installation through openings, heat leakage bridges).

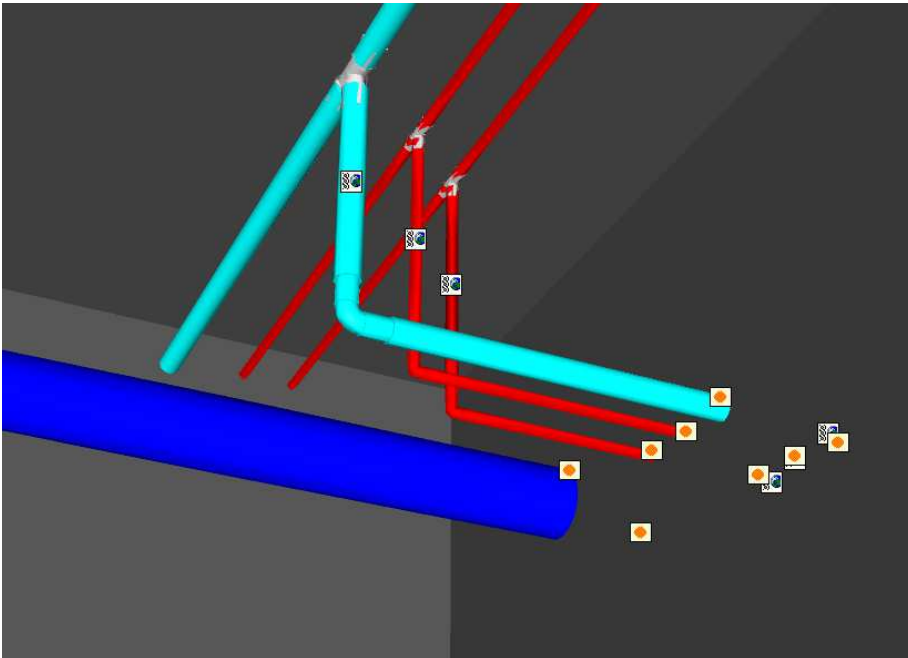


Foto: Example of clash detection.

AR

Augmented reality (AR) is the incorporation of a computer-generated image on a person's view of the real world. It provides a view of both what the world and work actually look like and what it could look like. The most popular augmented reality wearable in construction is the Microsoft HoloLens, but there are a growing number of companies developing their own wearables.



Foto: Example of Microsoft HoloLens (www.microsoft.com/en-gb/hololens)

This tool can be used both by the general contractor and the investor to check the sanitary installation model in real conditions before starting assembly work. The tool can help detect collisions and speed up the approval process of designed installations.

VR

Virtual reality (VR) is an interactive computer-generated experience taking place within a simulated environment. It incorporates mainly auditory and visual feedback. No matter how accurate schematics or concept renderings are, there's no better way of perceiving how a project will turn out than an accurate, detailed virtual render viewed with virtual reality technology. This tool will be used to better illustrate to employees how the installed installations should look like. Mostostal has Oculus Rift that will be used on experimental site to train the workers.



Foto: Model checking using VR

Checklists

This kind of methods can help workers check any steps in receive buildings. The other usability is that workers can control every places on the site which can be leaky.

Example of checklist which are made in Power Apps are shown below.

The screenshot shows a mobile application interface for a checklist. At the top, there's a blue header with a logo 'N' and the title 'Elementy'. Below the header is a search bar with the text 'Elementy wyszukiwania'. The main content is a list of items, each with a title 'Ściany - Żelbet_30cm', an ID 'ID: 445737', and a project position 'Pozycja projektowa: 91'. Each item has a right arrow icon.

Foto: Example of the checklist for acceptance of installation works.

Another method to do some checklists, improve quality and increase safety is use BIM 360 Field. Example of checklist in BIM 360 Field are shown below.

The screenshot shows the BIM 360 Field web interface for a checklist titled 'MW_02_REBAR CAGE'. The interface includes a header with 'Print Checklist', 'View Issues', 'Delete', 'Save', and 'Save + Close' buttons. The main form has fields for ID, Name, Description, Tags, Inspector, Drawing No., and Attached documents. The checklist items are: 1.1 Bottom table is on position, 1.2 Bulkhead match cast sides are on position, 1.3 PT duct masks are on position, right holes are covered. Each item has a 'Comments' field and buttons for 'Yes', 'No', 'N/A', 'Details', and 'Issues'.

1 CONFORMITY WITH ORDER

1.1	Delivery note is compliant with the order	Yes	No	N/A
	<input type="text" value="Tap to enter comments"/>			
1.2	All bundles, coils are marked correct, easy to identify	Yes	No	N/A
	<input type="text" value="Tap to enter comments"/>			
1.3	Quantity matches the order	Yes	No	N/A
	<input type="text" value="Tap to enter comments"/>			

5.2 Selected tools and learning methods in Poland

Type	Inventory of learning tools and learning methods in Poland	
Learning tool	Microsoft HoloLens	
	Oculus Rift	
	Checklists in Power Apps or BIM 360 Field	
Learning method	BIM Execution Plan (BEP)	
	Checklists	

Table 4: Summary table for the inventory of learning tools and learning methods in Poland

6. Results from Spain

6.1 Inventory of available tools and learning methods

STARTING POINT: the awareness campaign carried out in Valencia (31 May 2018)

On May 31, Valencian Institute of Building (IVE), in collaboration with the regional government, Generalitat Valenciana (GV), organized a technical session on the implementation of the BIM methodology in Valencia region.

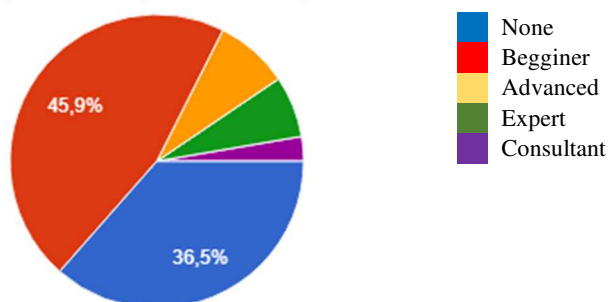
The objective was to raise the awareness of the attendees towards the importance that the BIM methodology is acquiring in recent years, and the level of implementation that already has in some European countries where its use is already mandatory in some cases. The session was attended by 150 people with different profiles, such as local authorities, architects, surveyors, builders.



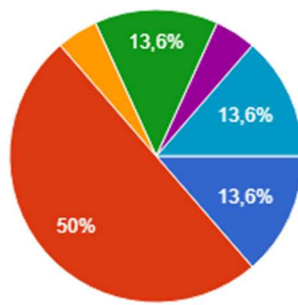
The participants filled out a “BIM maturity survey” whose results will be useful to establish the different training itineraries that must be adapted to the needs of the trainees according to their knowledge, responsibility and specific needs. Of the 74 responses obtained, it should be noted that:

- The majority knew the BIM methodology but half of them are considered at an initiation level.
- Only 30% have received training during the last year, but more than 93% want to be trained soon. The type of course they require is very varied.
- A third of respondents already use BIM in their workplaces, mostly in the design phase.

How will you define your knowledge and skills in BIM?

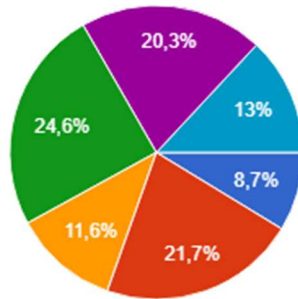


Which kind of training it was?



- Conceptual training course (short term)
- Initiation course to a BIM tool (short term)
- BIM course on collaborative work methodology (short term)
- BIM course for a specific discipline or use (short-term)
- Specialization course in BIM (medium duration)
- Master Course in BIM (long-term)

What kind of training you have in mind?



- Conceptual training course (short term)
- Initiation course to a BIM tool (short term)
- BIM course on collaborative work methodology (short term)
- BIM course for a specific discipline or use (short-term)
- Specialization course in BIM (medium duration)
- Master Course in BIM (long-term)

TRAINING METHODOLOGY

The training methodology that will be used is Blended learning. Blended learning is a hybrid teaching methodology that combines e-learning with traditional classroom methods. The learning will be based on three primary components:

- **Face-to-face** classroom and mockup activities.
- **Online training:** pre-recorded lectures, recommended readings, solved exercises...etc.
- **On-Site training:** training located at the job site. This type of training will be used for practical tasks.



Face-to-face training: spaces available at the IVE headquarters



CLASSROOM

Capacity: 32 people
Streaming available



MAIN HALL

Capacity: 90 people



DEMONSTRATION SPACE

Capacity: 90 people
Suitable for organizing flexible activities
such as workshops, product
demonstrations, etc.

Face-to-face training: spaces available at the SERVEF professional center in Picanya



CLASSROOM

- Capacity: at least 16 people, 30 m2
- Availability of computers for all the participants in the training programme.



DEMONSTRATION SPACE

The demonstration spaces includes façade, roof and floor mock-ups as well as all the tools, equipment and materials needed to carried out construction works.



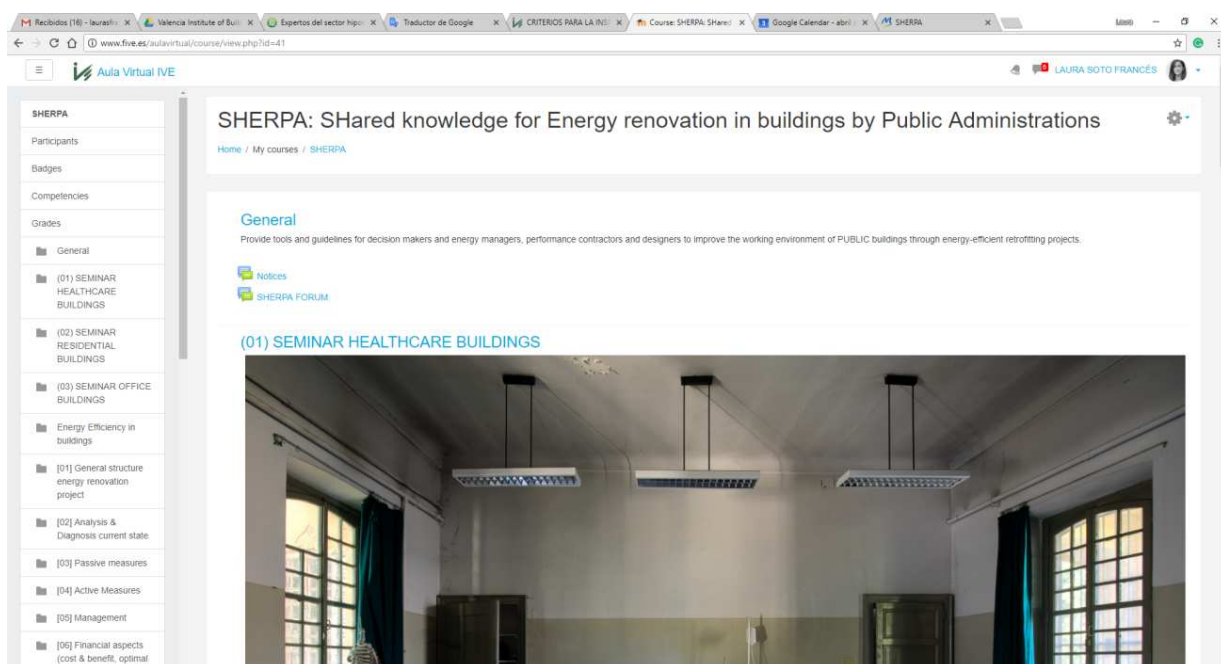
Online training: E-learning Platform “Aula Virtual IVE”



The E-learning Platform “Aula Virtual IVE” is based on Moodle. Moodle is a free and open-source learning management system. Developed on pedagogical principles, Moodle is used for blended learning, distance education, flipped classroom and other e-learning projects in schools,

universities, workplaces and other sectors.

With customizable management features, it is used to create private websites with online courses to achieve learning goals. Moodle (acronym for modular object-oriented dynamic learning environment) allows for extending and tailoring learning environments using community sourced plugins.



The material available through this e-learning platform will consist of:



PRACTICAL INFORMATION

Practical information about the course: agenda, content, teachers, evaluation criteria, contact



CONTENT

The documentation of the sessions will be available online: presentations (pdfs) and videos



COMPLEMENTARY MATERIAL

Related publications, links of interest, videos, texts, audios, articles, downloads, etc.



TEST

Optionally, one or more tests can be performed throughout the course.



FORUM, MESSAGES, ALERTS

Open communication between teachers and students for consultation, resolution of doubts, etc.

On-site training: selection of works located in the Valencian Community (on going)



TRAINING MATERIAL

Training materials will be designed by different professional experts, with the purpose to develop not only BIM related content but also cognitive abilities including understanding, procedural and mental skills allowing construction sector workers to put into practice the acquired knowledge in concrete situations.

BIM

Workers attending the courses will need basic knowledge on BIM methodology. Open source material on BIM already available will be used to provide the attendees the necessary skills to take the most advantage of the BIMplement training.

It should be borne in mind that in the case of Spain, most blue collars and some white collars have no previous training in BIM. CYPE and Ive will cooperate in order to provide BIM tools to attendees.

Examples of BIM open source material:

- BIM Awareness training
One of the deliverables of the EU-project Net-UBIEP is an awareness training for workers. This awareness training will be a short e-learning module and a classroom variant.
- BIM training from BuildingSMART Spanish Chapter:
Building pills: <https://www.buildingsmart.es/recursos/pildoras-bim/>
UBIM Guide: <https://www.buildingsmart.es/recursos/gu%C3%ADas-ubim/>
- BIM MOOCs: some examples:
Zigurat: <https://www.bimcommunity.com/promotions/bimacero>



- Fundación Laboral de la Construcción:
<http://www.fundacionlaboral.org/actualidad/noticias//nuevo-nuevo-curso-gratuito-on-line-para-titulares-de-la-tarjeta-profesional-de-la-construccion-centrado-en-la-metodologia-bim>
Autodesk: <https://www.youtube.com/watch?v=RN1JfK6Wi2w>

NZEB, Ventilation and air-tightness

Workers will be provided with basic information on the topics at project level (NZEB, ventilation and air-tightness) to standardize the knowledge of the workers attending and to reinforce good practices.

The training material will be provided by IVE experts based on the previous training courses on this topics.

T1c Mejora de la calidad ambiental en el edificio y la vivienda



Arquitectura y Ventilación. Sistemas Pasivos y Activos
Arquitecto López, (Diseño Industrial)
Ignacio Guillén, (D. Arquitecto)

3

T1c Mejora de la calidad ambiental en el edificio y la vivienda

¿Porqué la ventilación?

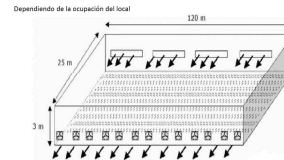
¿Porqué la ventilación?

Para tener en cuenta el aspecto del confort térmico:
la renovación de aire no debe producir corrientes que supongan sensaciones desagradables a los ocupantes.
Para dar una orientación, estas corrientes no deben superar los 0.1m/s de velocidad en la cercanía de las ventanas.
A partir de este valor, la sensación de incomodidad puede ser muy notable.
Los problemas de contaminación del aire interior y por los que hay que disponer de un sistema de ventilación, son principalmente tres:
• Presencia de gases carbónicos, por la respiración de los ocupantes
• Humo
• Olores y microorganismos.

6

T1c Mejora de la calidad ambiental en el edificio y la vivienda

¿Porqué la ventilación?



7

In addition, open knowledge sources, materials and quality control methods focused on nZEB, ventilation and air-tightness collected in the Task 3.2 will be analysed case per case in order to identify those contents that are applicable in each of the experimental sites.

For the specific case of training unemployed people, SERVEF will incorporate BIMplement contents to the training programme “Energy renovation and accessibility in buildings”, which is a 170 hours training programme already approved by the Spanish Ministry of Employment as professional qualification. Module 1 of this training programme (86 hours) is focused on the energy renovation of buildings including, among others, the following concepts, which are aligned with BIMplement topics: nZEB and air-tightness:

- Introduction to the concept nZEB: passive bioclimatic solutions.
- Improvement of thermal insulation of the building envelope.
- The building envelope: thermal bridges and windows. How to replace windows.
- Building roofs: improvement and renovation of building roofs.



**PROGRAMA FORMATIVO
REHABILITACIÓN ENERGÉTICA Y DE
ACCESIBILIDAD DE EDIFICACIONES**

Noviembre de 2017

http://www.labora.gva.es/documents/164200219/164200548/EOCB06EXP_+REHABILITACIO%cc%81N+ENERGE%cc%81TICA+Y+DE+ACCESIBILIDAD+DE+EDIFICACIONES-1.pdf/84e0b2df-eea6-4b6f-a1fa-9d8d7eb28ff4

This training programme will be complemented by BIMplement contents including the use of BIM as a information carrier to improve the quality of renovation activities in buildings.

Transversal abilities

The training will include cognitive abilities as for example learning to learn, new technologies understanding and procedural and mental skills allowing construction sector workers to put into practice the acquired knowledge in concrete situations.

Professional out of the construction sector (phycologist, sociologist...etc.) with specific knowledge on this area, will design the programme and activities.

COLLABORATORS

BIMplement courses (tools, methods, contents,) will be validated by the **BIM Innovation Group in the Valencian Community**. This group is led by the regional government (Generalitat Valenciana) and is formed by all the agents of the construction sector (Building developers, Investors, Construction, Engineering, Architecture Studies, Software Developers, Facility and Project Managers, Research Centers, Manufacturers of Products and Materials, Universities and Public Administrations).

At the national level, we keep a strategic contact with the "[Building Smart Spanish Chapter](#)" that is part of "[Building Smart International](#)". This non-profit association is very active and organizes congresses and events every year, has high-quality open source training material, and has among its members experienced teachers.

More specifically, the collaboration of **private companies** that can provide added value in their fields of expertise is expected (TBC):

- CYPE: software company ([+ info](#))
- SIBER: manufacturers of ventilation products and systems ([+ info](#))
- SIKA: manufacturers of products and systems that guarantee air tightness ([+ info](#))
- Construction companies that currently work with BIM methodology and are interested in training their own workers. They must also allow access to some of their works located in the Valencian Community to carry out on-site training for small groups of students
- Architects and engineers who have participated in a building project (design phase) with BIM methodology. The project must be in the construction phase at present and allow the access of small groups of students to carry out on-site training.

6.2 Selected tools and learning methods for Spain

Type	Inventory of learning tools and learning methods for Spain
Learning tool	BIMtools validated by the BIM Innovation Group in the Valencian Community
Learning method	Blended learning [mix of Face-to-Face, Online and Onsite training]

Table 5: Summary table for the inventory of learning tools and learning methods for Spain

7. Results from Lithuania

7.1 Inventory of available tools and learning methods

Awareness campaign

RIMC together with LBA are responsible for awareness campaign strategy and implementation in Lithuania. Both organisations collaborate with public institution “Digital Construction”, which involves 12 business and professional associations (including LBA) in Lithuania interested in BIM implementation issues. All associations unite a high number of companies and professionals involved in construction sector. Public institution “Digital Construction” serves as a platform for approaching multiple stakeholders in Lithuania. LBA also acts as liaison with governmental institutions responsible for regulation and control of activities in construction sector.

Currently, LBA is closely involved in mapping existing in Lithuania BIM competences models, training courses, and certification schemes with newly introduced BIM competence model, certification scheme developed by BuildingSmart international alliance. Accordingly, BIMplement methodology is also under integration process with renewed Lithuania BIM competences model structure.

BIMplement awareness campaign was implemented on collective and individual basis depending on the type and needs of specific stakeholders. It is an ongoing activity that started during 2018 and will continue in the course of the project. On individual basis a couple of meetings took place that among other issues also covered some BIMplement topics, especially, opportunities to use BIM for quality purposes, supposedly using BIMplement methodology, which is currently at the finalisation stage. Construction companies like UAB Mitnija, Žilinskis ir Co, Yit Kausta and others were involved in discussions regarding possibilities to become experimental sites.

Training strategy

Before proceeding with the training it will be necessary to ensure that BIM model is available for the pilot sites. **An initial assessment, while using the national BIMawards criteria will be used for project evaluation based on the data from questionnaire. The starting point for the selection of the pilot sites will be approaching large companies that have higher quality BIM projects but mainly target their Subcontractors, which in most cases include SMEs, who need to become a part of BIM related processes to ensure nZEB requirements are met to the full extent. The companies would be classified based on existing BIM processes - a) Low maturity level >80% change is required; b) Medium maturity level >50% change is required; c) High BIM maturity level. BIMplement will provide additional content and training based on agreed scope that will complement existing competences of the companies.**

BIMplement training scope will be followed by these steps:

A. Meeting with managers of companies to agree on project selection

B. Initial assessment of the BIM model and BIM processes with the selected Project Manager and BIM team;

C1. Training of project parts managers and engineering personnel (level 6-7, EQF);

C2 Brigadier (level 5, EQF) and Blue Collors training (level 2-4, EQF);

Selected Field lab - Digital construction (Public institution) www.skaitmeninestatyba.lt, which has necessary training infrastructure for delivering BIM related trainings. Meetings with stakeholders for arrangement of at least 5 experimental sites will be held. Training of trainers for implementing BIM

as a workplace learning environment will take place in the field lab and, accordingly, the trainers will transfer this knowledge to the persons working at the experimental site.

Tools that will be used

Project partners in Lithuania will extensively use results of the project, especially results produced in WP 3 and 4. National (Lithuania) cloud-based construction classification system, <http://ics.infinibim.com/> will serve as a foundation and will be used for implementation of BIMplement competence model in Lithuania aligned with other competence models related with BIM and nZEB. Classification structure will include construction project stages, use cases (management processes), BIM model functional and technical systems, elements, construction technology processes, actors, competences, skills, knowledge, and other structure components.

For the presentation of BIM model BIMAXON and other BIM model development, simulation, coordination, visualization software will be used for different use cases. Initial list of different BIM Viewers common in Lithuania is provided below:

1. TeklaBIMSight;
2. Solibri Viewer;
3. Naviswork Freedom;
4. Autodesk Design Review;
5. Bentley Navigator

Cloud based:

1. Autodesk A360
2. BIM+

Training resources

Portals

The content of training will be filled, while using www.statybostaisykles.lt and <https://statreg.lt/>. www.statybostaisykles.lt will be the main source for the content related to construction technologies, process descriptions, competence requirements for NZEB in at least 14 technology areas developed during ENERGOTRAIN project. The details of quality check measures available at national level are provided in D 3.3. The system is already used by more than 700 companies in Lithuania, and more than 2000 professionals from construction sector. PROF/TRAC platform and results of other project, including UBIEP, will also be explored and potentially used as an additional valuable EU level source for the use of the nZEB related training content.

STATREG <https://statreg.lt/> will be used for register of the new competence framework and those who will go through the training and would like to validate their competences at sectorial level. It is a new system for voluntary assessment of the competences and qualifications of the construction sector employees, which acts as the information portal, the register of competencies and the tool for analyzing the needs of all construction sector. Those who will wish to enter the Builders' Register and receive the Builder's Card will need to first sign up and specify the desired competencies as well as the required data. The card samples are provided in pictures below.



Front



Back

The portal will also contain information about all trainings planned and implemented during BIMplement project. Customers and prospective employers will be able to check the portal and see the qualifications and competences of their staff. The card or personal permissions provided by the builder shall be used for this purpose. The data could be viewed through QR code reader on smartphone or a personal password or code. Employers can manage the qualifications, competencies and training of its employees, can invite tenderers to reference the STATREG register. Employers will find information on training and further training in accordance with the required competencies. The portal provides an opportunity to search for builders who are not currently working, but have required and validated competences. Finally, the portal will help to forecast preliminary needs for labor resource, training and qualifications and many other useful information about the competencies and qualifications of the construction sector staff.

BIM training

The goal of the BIM qualification improvement curriculum for the digitization of the construction process is to provide the general knowledge of the digitization of the construction process and the information modeling of the building (BIM) and to develop the business skills to apply them in practical activities. The qualification improvement training program is intended for managers of key technical areas of construction. After listening to this course, the students will be able to work with the tools used in the BIM process, understand the general principles of preparation, storage and management of construction information. The program consists of the following modules.

BIM tools

Knowledge of BIM solution providers (like AGA CAD, www.aga-cad.com) will be used to ensure a proper market and technology knowledge to the companies that will participate in the project and provide pilot sites.

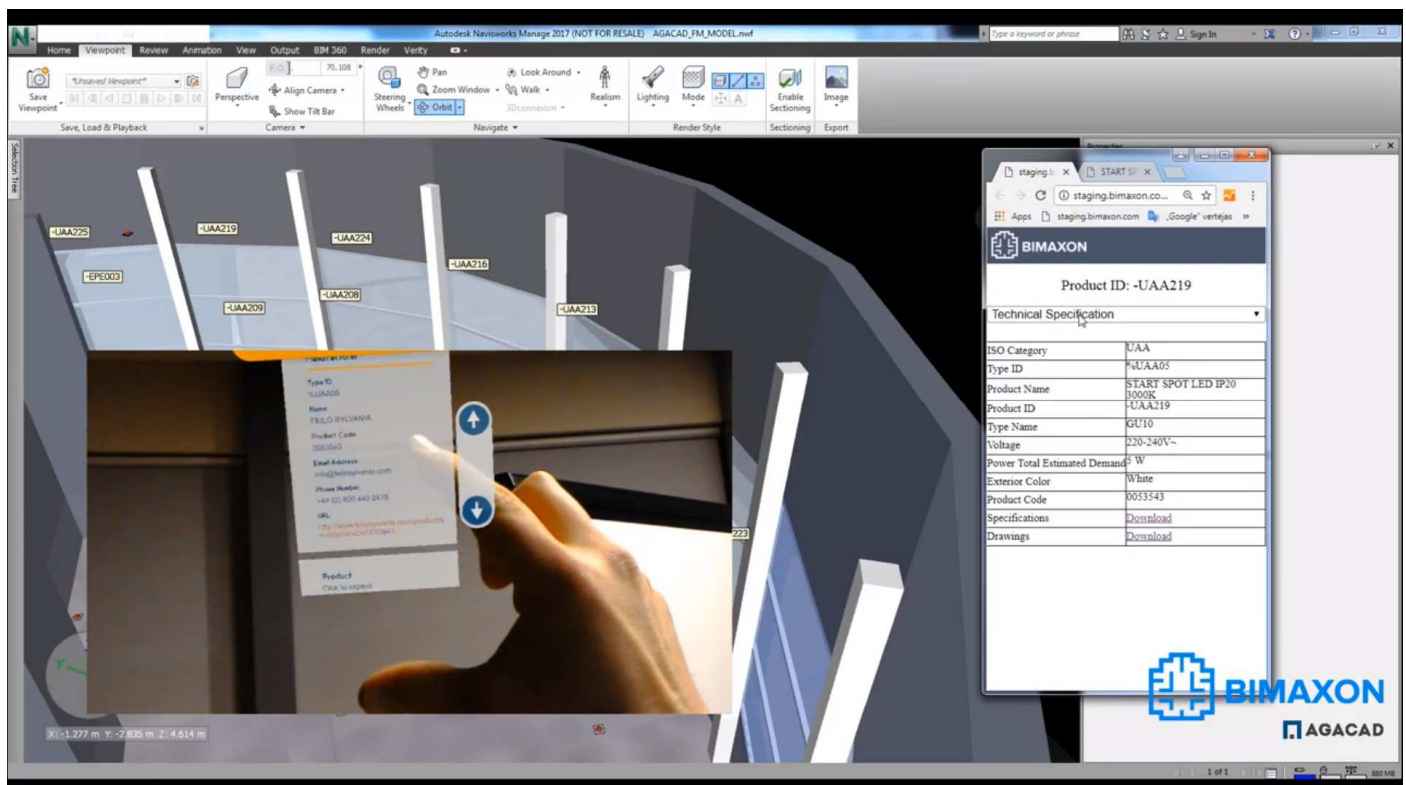
The following workflow will be learned:

1. 3D Laser Scanning
2. Modeling in Revit
3. Sync with BIMAXON CDE in Navisworks
4. Sync with MS SharePoint in BIMAXON WEB
5. Asset management in SharePoint Online (Included in Office 365 package)
6. Asset analysis in SmartPhone and MS HoloLens

The same workflow is for New BIM projects except 1st task (3D Laser Scanning).

Here is a video of BIMAXON.

<https://youtu.be/WvwB7Z4UXns>



The training will include:

- Preparatory steps
- Personal registration
- Create an account
- Assigning people to your account
- Designation of construction participants
- Creation and payment of the magazine
- Arrangement of structural elements
- Estimate (workload list)
- Assigning the account holders of the Building Participants to the magazine (Account and its employees in a specific journal).



Typically, a journal entry involves:

- contractors (designers, geodesists, subcontractors, etc.), who make records of work done,
- construction technical supervisors (general and special construction works), which confirm the records of the contractor and make entries in the notes,
- the customer who follows the progress of the work, and a whole range of inspection organizations whose mission is to ensure the enforcement of the law on construction sites.

7.2 Inventory of learning tools and learning methods in Lithuania

Type	Inventory of learning tools and learning methods in Lithuania
Learning tool	TeklaBIMSight
	Solibri Viewer
	Naviswork Freedom
	Autodesk Design Review
	Bentley Navigator

Learning method	Autodesk A360
	BIM+
	An initial assessment, using the national BIMawards criteria
	Using modern and adequate infractructure for delivering BIM related trainings representative to workplace settings

Table 6 : Summary table for the inventory of learning tools and learning methods in Lithuania

COLOFON

BIMplement



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