

INSITER & IMPLEMENTATION TRAINING



INSITER INTUITIVE
SELF-INSPECTION
TECHNIQUES

INSITER IMPLEMENTATION TRAINING



TABLE OF CONTENTS

1. Setup of the INSITER implementation training modules
2. Quality assurance
3. Introduction to INSITER
4. INSITER collaboration platform
5. Implementation 8-STEP methodology
6. Benefits INSITER & the 8-STEP methodology

SETUP OF THE INSITER IMPLEMENTATION TRAINING MODULES

- Introduction
- The INSITER toolset
 - The collaboration platform
 - BIM-model & data
 - Guidelines
- The INSITER 8 step methodology
 - Off-site (preparation)
 - On-site (execution)
 - Actors and qualifications
 - Simulation based self-inspection of the building and HVAC/MEP systems



MAKING OR RENOVATING A BUILDING

Making or renovating a building together needs a lot of different construction and installation workers. Everyone wants to do his work good.



SOMETIMES THINGS GO WRONG:



Indentation of ducts



Thermal bridge

(Sewage) pipe in cavity wall



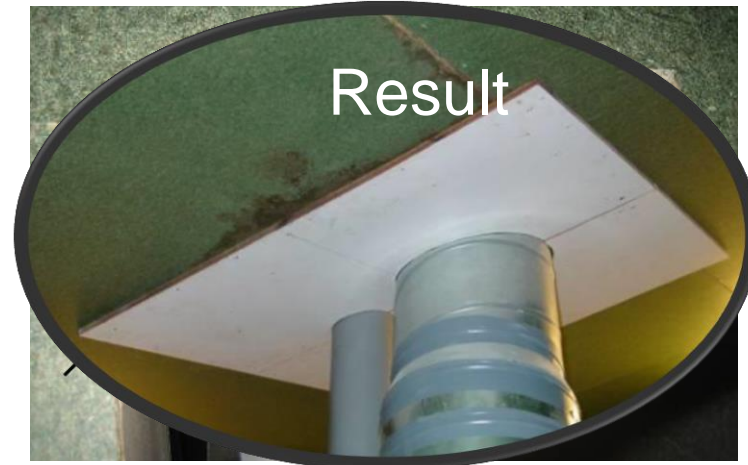
Construction waste/
dirt in ducts



SOMETIMES THINGS GO WRONG:

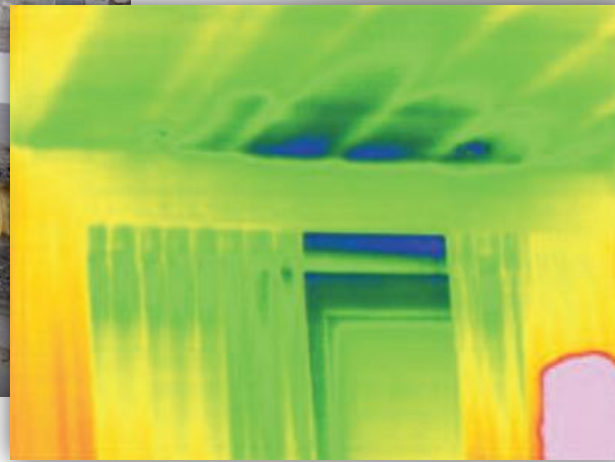


Unprotected storage of ducts



Result

Wrong application of water membrane



Sealing of hollow core floors



MAKING A (SUSTAINABLE) BUILDING

Important:

- (New) buildings have to consume less energy.
- Building becomes more complex:
 - Improved construction detailing
 - New techniques (Heatpumps, prefabricated wall parts)
- The indoor air quality must be good.
- Materials have to be re-used.

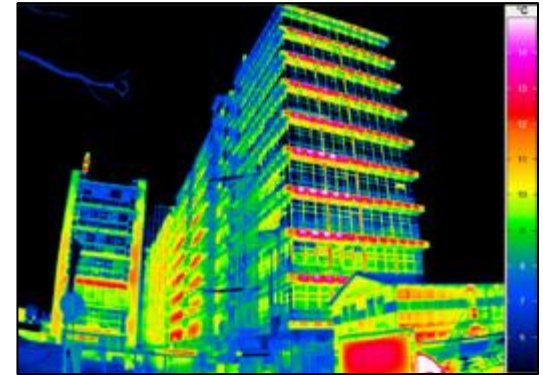
This means:

Mistakes in building have a big(ger) influence on:

- Energy
- Indoor air quality
- Re-use of materials



Quality assurance can reduce these mistakes.



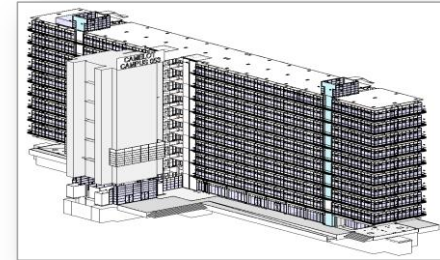
WHAT IS QUALITY ASSURANCE?

The check and demonstration of the quality delivered in a project.

Quality Assurance for Customers:

A building with:

- a satisfied customer
- Better quality
- Fewer defects
- In accordance with the agreed performance



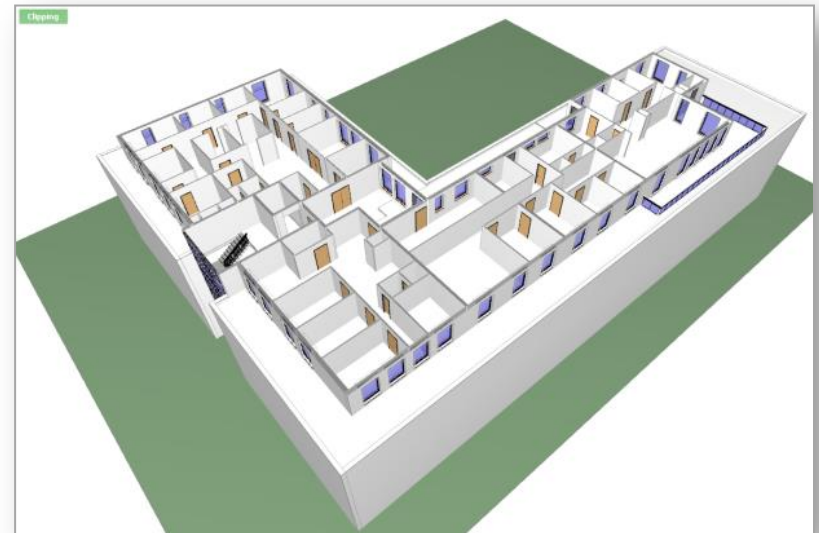
WHAT IS QUALITY ASSURANCE?

The check and demonstration of the quality delivered in a project.

Quality Assurance for Contractors:

Risk management:

- Reducing gap between as designed and as-built
- Reducing failure costs
- Increasing construction workers satisfaction
- Increasing customer satisfaction



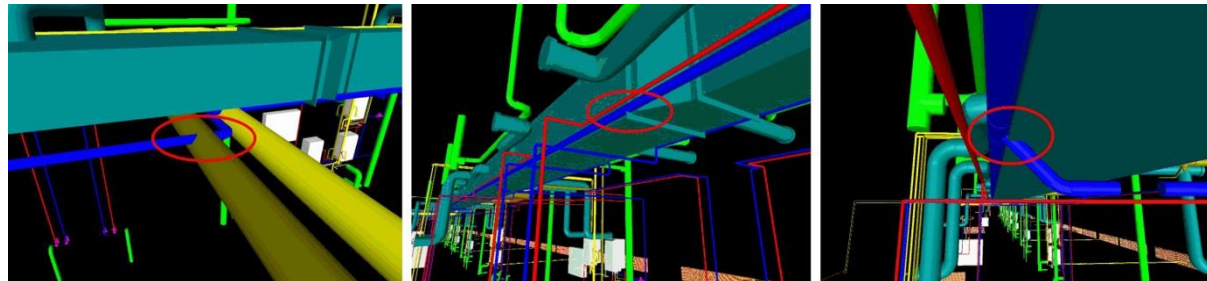
WHAT IS QUALITY ASSURANCE?

Quality assurance helps the contractor to build better by:

- Identifying the risks in advance
- Defining required quality checks during design, building and the first stages of the use phase

Advantages:

- Errors or deviations during construction can be prevented
- Improves the quality of the final building
- Ensures that the intended 'sustainability' is realized



INTRODUCTION INSITER

- Quality assurance and INSITER
- Why INSITER?
- What is INSITER?
- How to implement INSITER?



QUALITY ASSURANCE & INSITER

INSITER innovates Quality Assurance



WHY INSITER? MAIN OBJECTIVE

To eliminate gaps in quality and energy-performance between design and realisation of energy-efficient buildings made of prefabricated components.



WHAT IS INSITER?

- INSITER is a European research project with the aim to develop intuitive and affordable tools for self-instruction and self-inspection with the help of Augmented Reality (AR) and BIM.

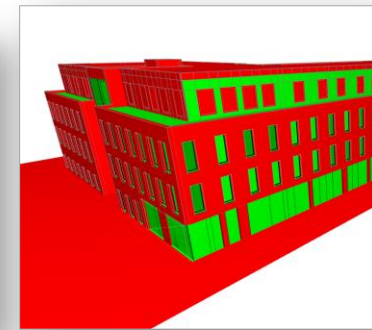
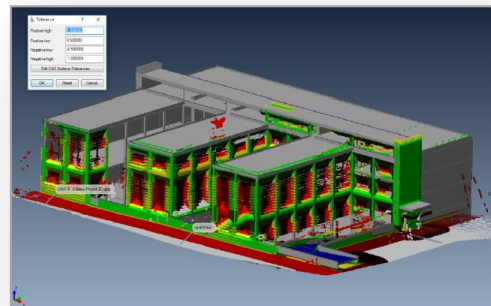
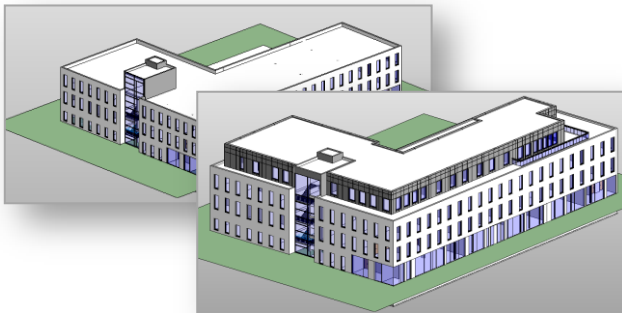


SCOPE OF INSITER

- Self-inspection techniques for the worker
- Use of smartphone, IPad, etc. to improve the building site
- Avoiding thermal bridges, control air-tightness in energy efficient buildings.



- Reduce time and save money in the building process.
- Check the solutions in real buildings



IMPROVEMENT OF QUALITY ASSURANCE BY INSITER

Mission:

Improve the energy-efficiency and the building quality

Changes by INSITER:

- From instruction before/never to self-instruction on-site & just in time
- From inspection after realisation to self-inspection during realisation

Solution:

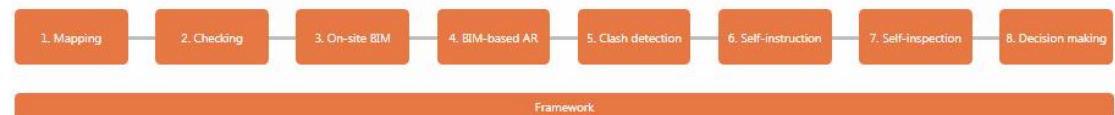
INSITER 8-step
methodology and toolset



Welcome to the INSITER collaboration platform. This platform serves as a central hub to exchange information and data throughout the INSITER process, and is both human as well as machine readable.

The platform is hosted by DEMO Consultants. If you do have any questions or need assistance please contact info@demobv.nl

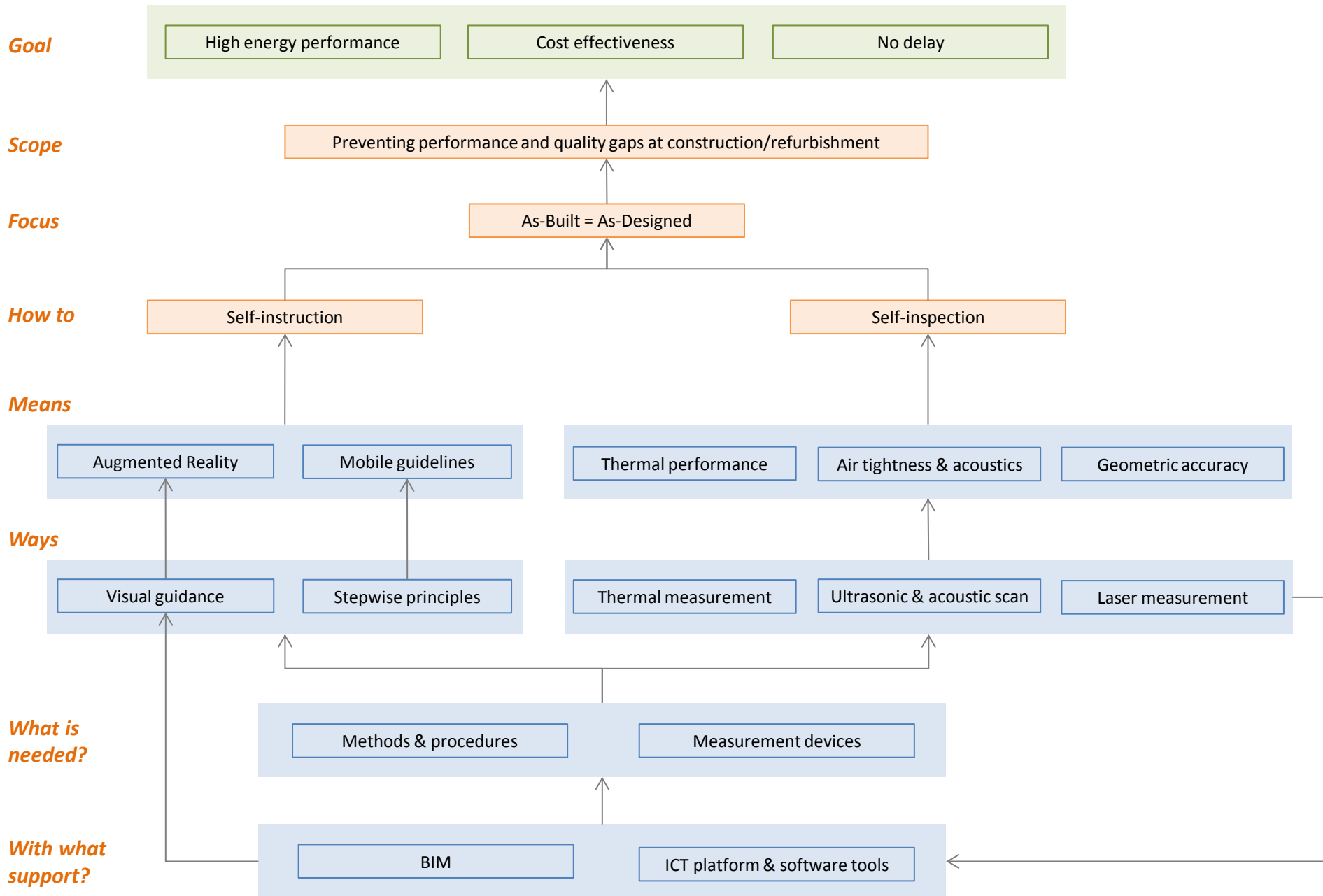
The INSITER Toolset



INSITER: INTUITIVE SELF-INSPECTION TECHNIQUES USING AUGMENTED REALITY



OVERALL INSITER RESEARCH SCHEME



8-STEP INSITER METHODOLOGY GUIDING QUALITY ASSURANCE

A new “8-step” methodology is developed for:

- New construction
- Refurbishment

Energy-efficient buildings made of prefabricated components

Main goals:

- Guiding implementation of quality assurance
- Involve workers with self-instruction and self-inspection



8-STEP INSITER METHODOLOGY

STEP 1: Mapping

Identify the real environment on-site, where the work should be performed

STEP 3: BIM on site

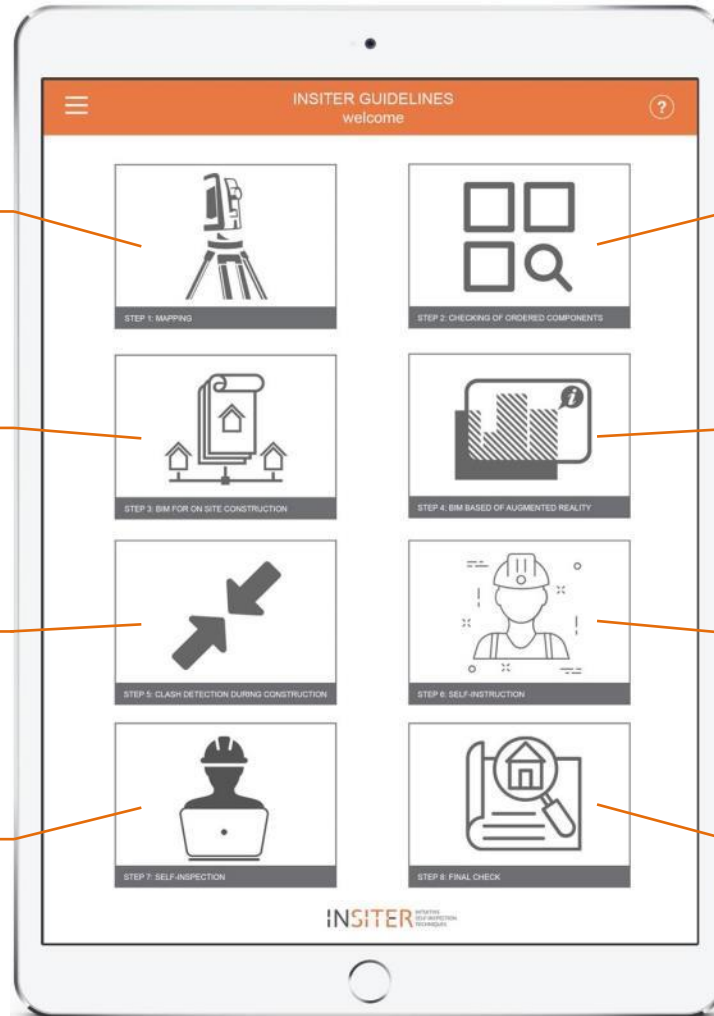
Deploying BIM on construction site

STEP 5: Clash Detection

Verification of the current site situation

STEP 7: Self-Inspection

Verify the current application or installation and fill in checklists for further processing



STEP 2: Checking

Check delivered components against design by using QR-Code for identification and verification

STEP 4: BIM based AR

Validate delivered elements against design requirements

STEP 6: Self-Instruction

Guiding the construction process using a mobile device

STEP 8: Final Check

Quality, time and cost evaluation by the Construction Managers

TOOLSET NEEDED FOR IMPLEMENTATION INSITER

Toolset: Heterogeneous but interconnected set of software tools- hardware tools

The toolsets:


- A collaboration platform
- BIM-model & data
- Guidelines
 - Linked instruction materials
 - Linked inspection materials



8-STEP METHODOLOGY COLLABORATION PLATFORM

SharePoint

BROWSE PAGE

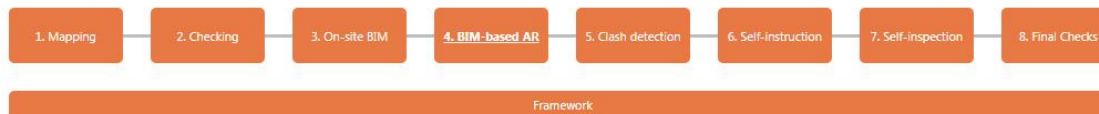
- Home
- Documents
- Manuals
-  EDIT LINKS



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The INSITER Toolset



4. BIM-based augmented reality

Tools

INSITER BIM AR Vision

Description:
The INSITER BIM AR Vision App is designed to visualize large geometry BIM models with referenced planning data in AR.

Metadata:
Actors on-site will be able to evaluate 3D building elements for self-

Devices

Tablet Computers

Description:
MS Windows 10 Surface Tablets

Metadata:
Mobile devices such as tablet computers (with MS Windows 10 as operating system) are utilized for BIM-based AR.

THE INSITER COLLABORATION PLATFORM EXPLAINED

SHAREPOINT

- Central hub to visualize and provide access to the INSITER toolset
- Document store which serves as the exchange of files and data between tools

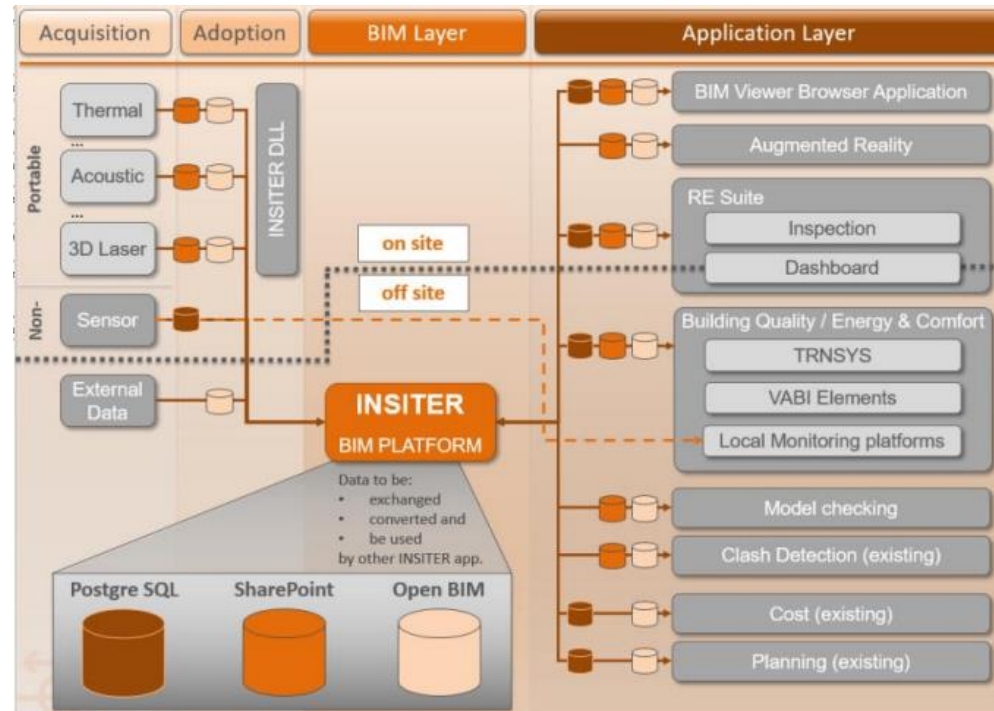
Tools and devices in the collaboration platform:

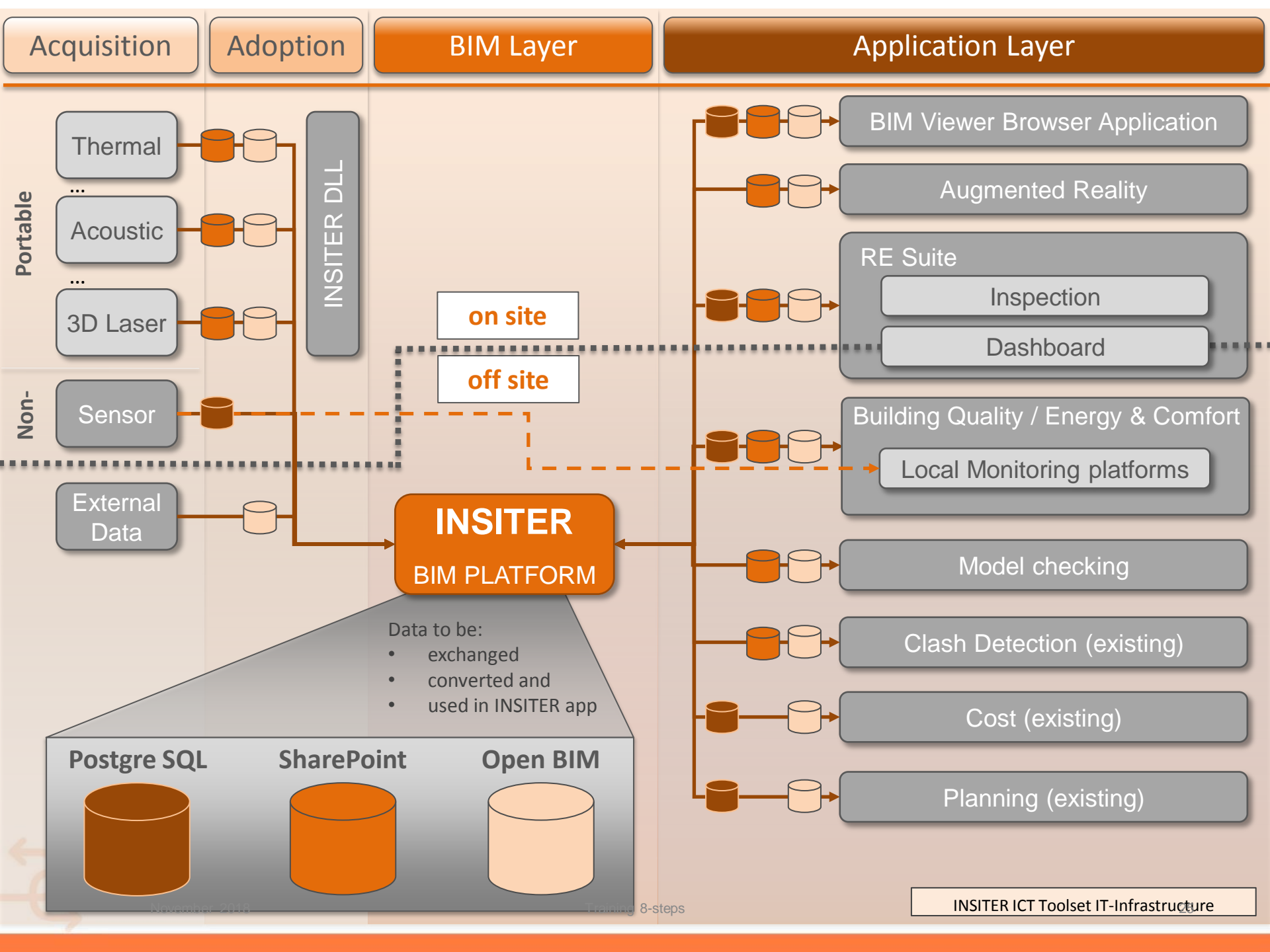
- Categorization the INSITER 8-step model step
- Description
- Metadata
- Link to access the tool or device
- Documents (such as manuals)



THE INSITER COLLABORATION PLATFORM EXPLAINED

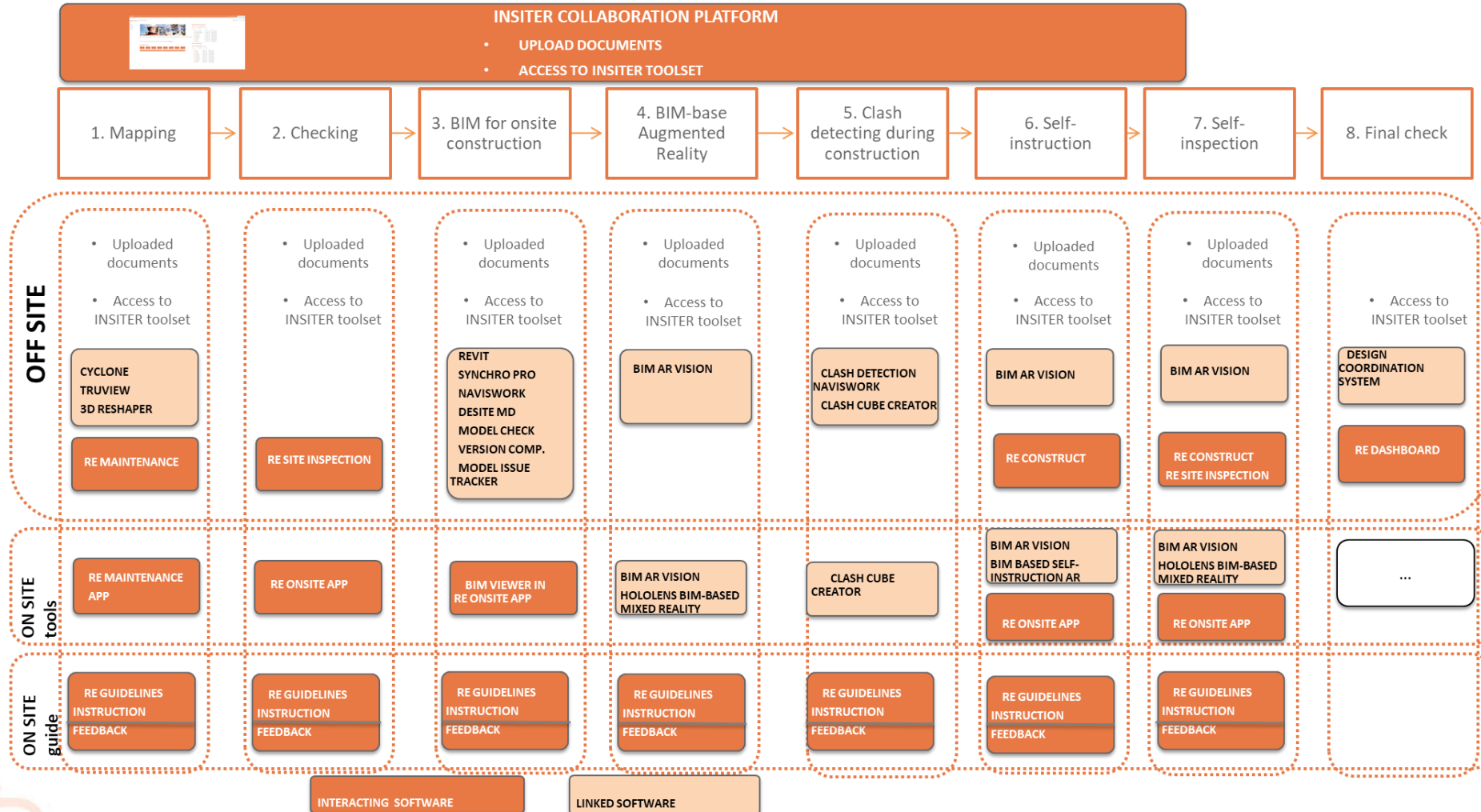
- Sharepoint: Databases behind it
- INSITER DLL: Library with results
- Tools involved: IFC viewer
- Backoffice dashboard, where collaboration takes place
- Guideline app, for construction workers on-site
- RE-on site app (for reading the QR codes and performing checks)



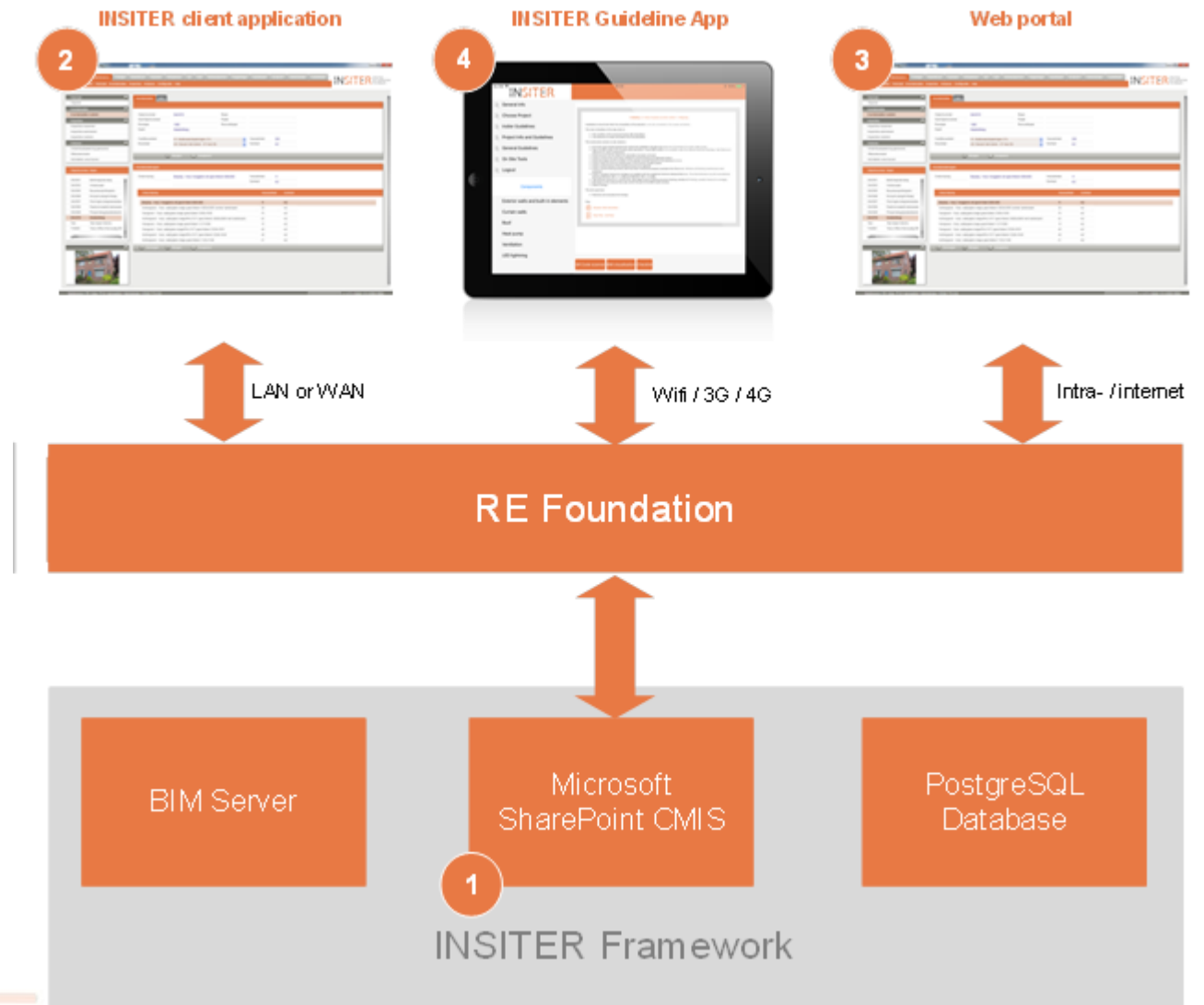


COLLABORATION PLATFORM/ TOOLS IN INSITER

INSITER Collaboration Platform with interacting and linked software per INSITER step:

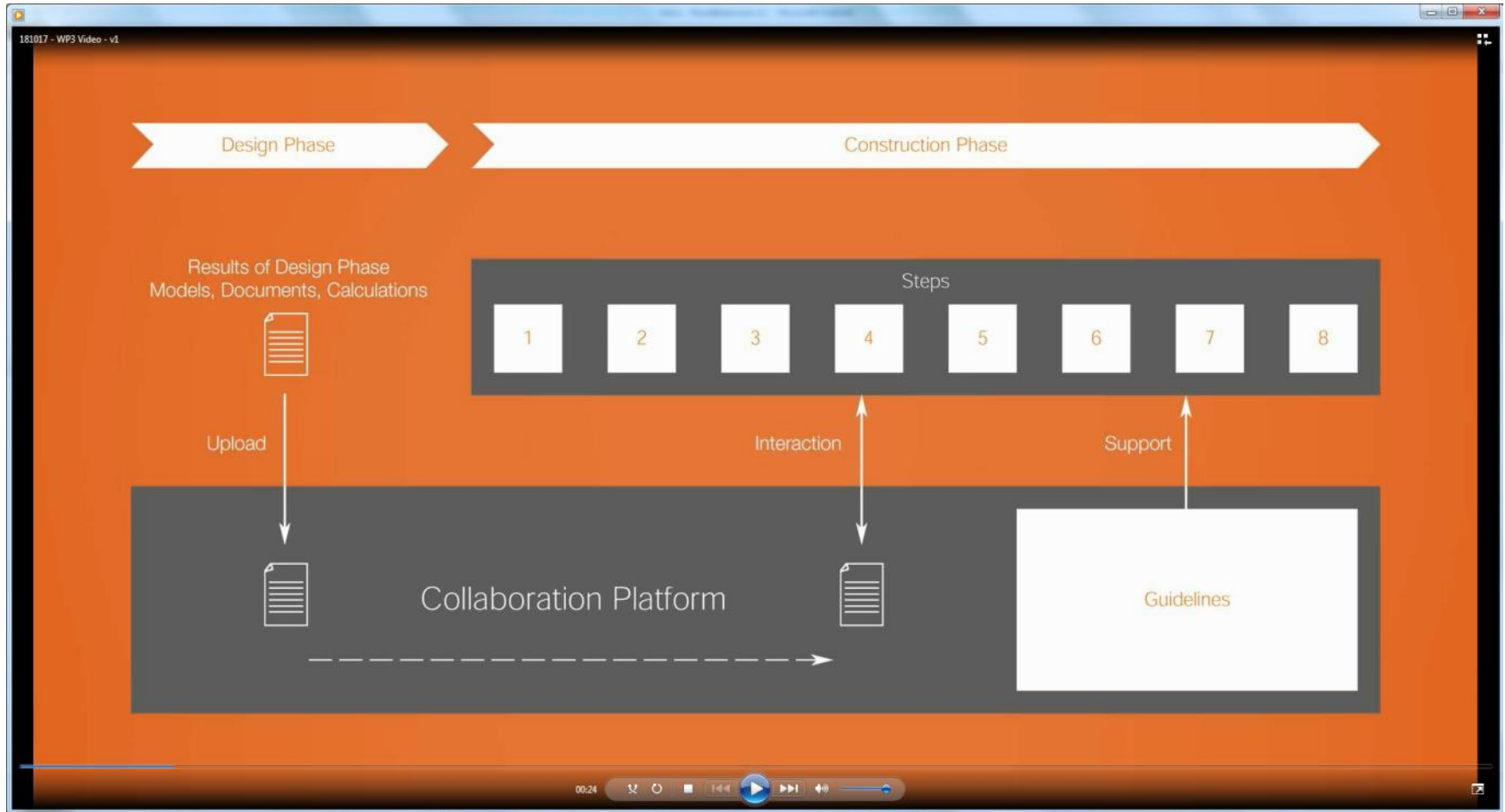


COLLABORATION PLATFORM/ DATABASES

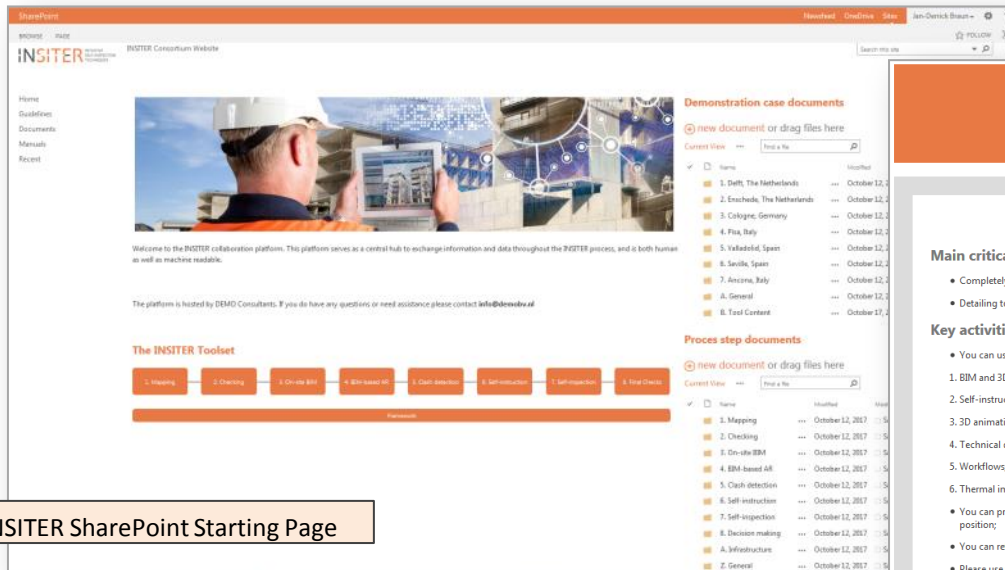


COLLABORATION PLATFORM/ SOFTWARE

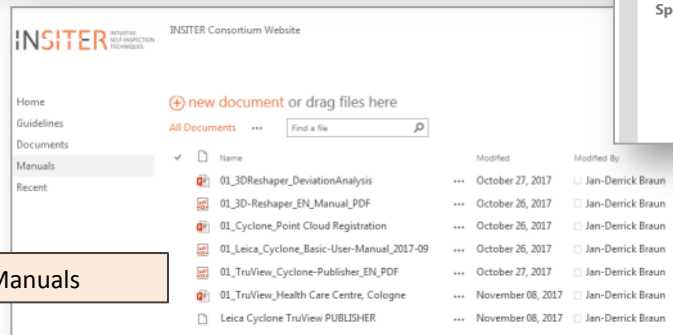
Presentation of the software



COLLABORATION PLATFORM INSITER: SHAREPOINT SERVER / TECHNICAL BACKEND



INSITER SharePoint Starting Page



INSITER Manuals

INSITER Guidelines Explorer

Project Type: 1. Existing | Critical Component: 7. Ventilation system | INSITER Step: 4. BIM-based AR

1. Existing | 7. Ventilation system | 4. BIM-based augmented reality

Main critical points:

- Completely and accurately follow the building design;
- Detailing to be followed.

Key activities:

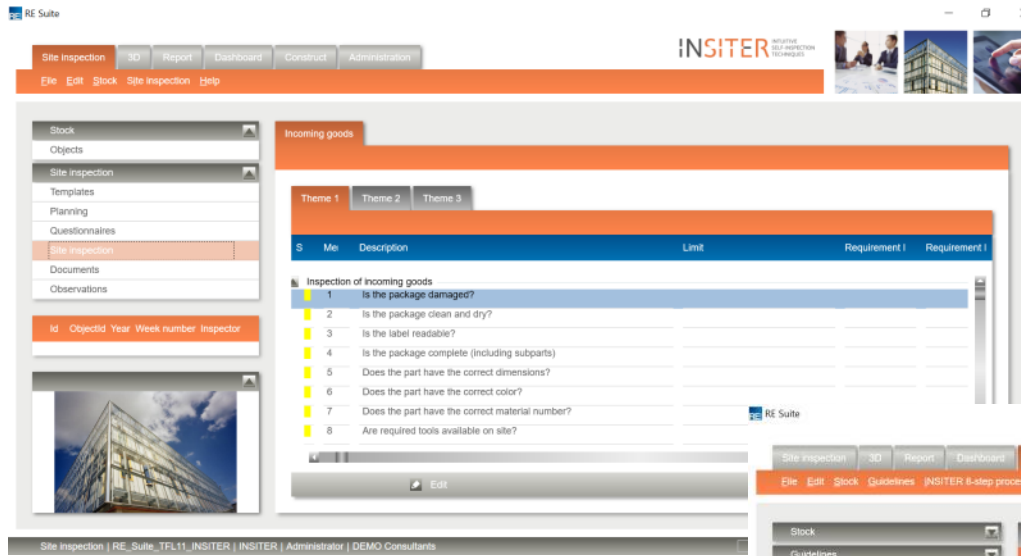
- You can use here one of the BIM-based AR solutions for INSITER to visualize:
 - BIM and 3D objects on-site environment;
 - Self-instruction data with process sequences;
 - 3D animations;
 - Technical details;
 - Workflows;
 - Thermal images, acoustic measurements.
- You can project on real environment the ventilation system to be installed so that you can check visually the correct location and construction position;
- You can retrieve and project through BIM the above information (2-6);
- Please use this material as a reference and try to understand your tasks and the expected result;
- Note down on the observation panel any remarks, questions or doubts.

Special attention:

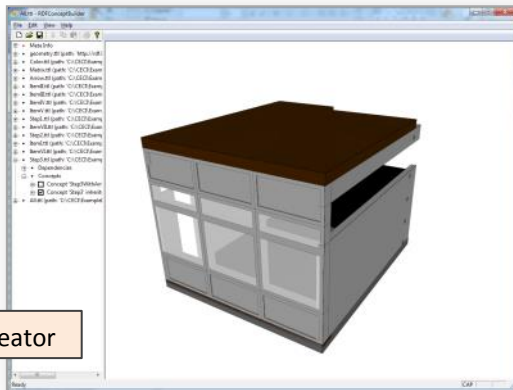
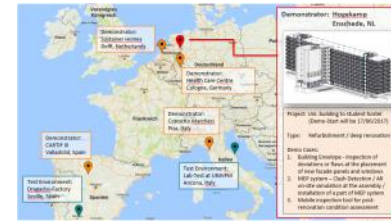
- Be sure that all hardware and cameras are calibrated;
- Be sure that AR markers are placed and will remain in the same position as long as you
- AR markers should be visible around your working area;
- Use the markers for the initialization of the applications and your navigation;
- If AR markers are combined with marker-less tracking make sure that supplementary

Project related Documents

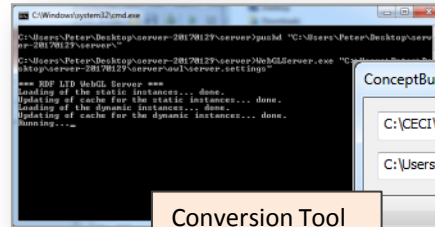
COLLABORATION PLATFORM INSITER: : RE SUITE DESKTOP APPLICATION



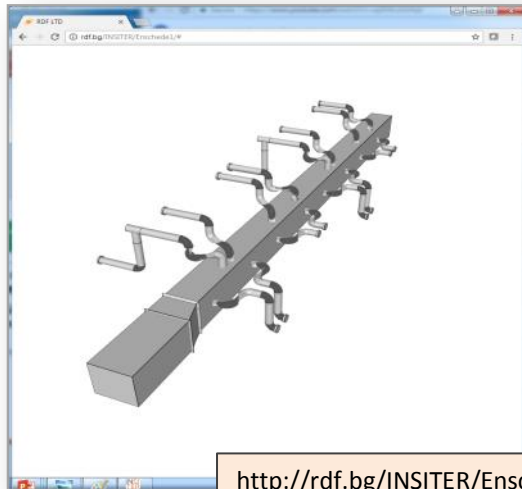
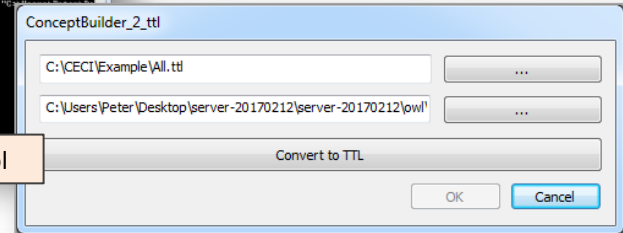
COLLABORATION PLATFORM INSITER: : RDF 3D SELF-INSTRUCTION MODEL CREATOR



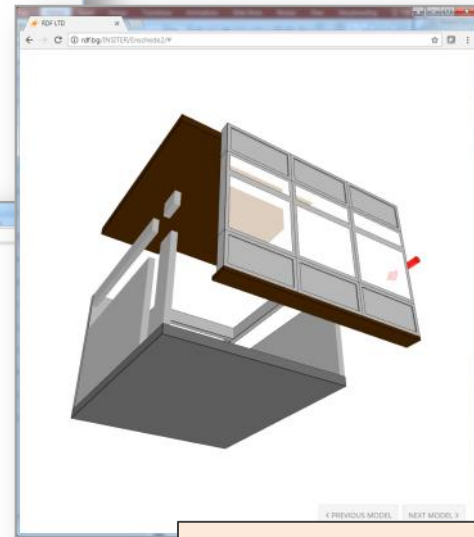
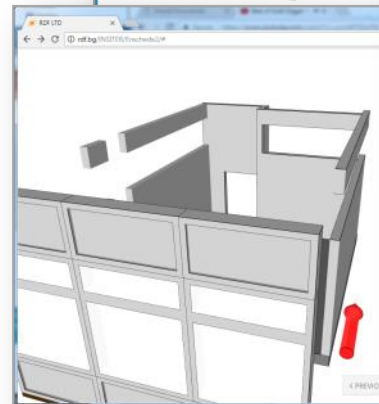
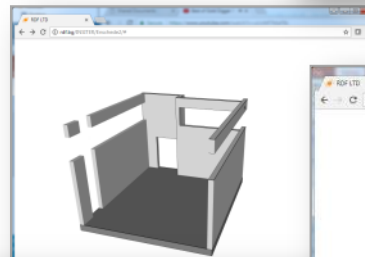
Content Creator



Conversion Tool

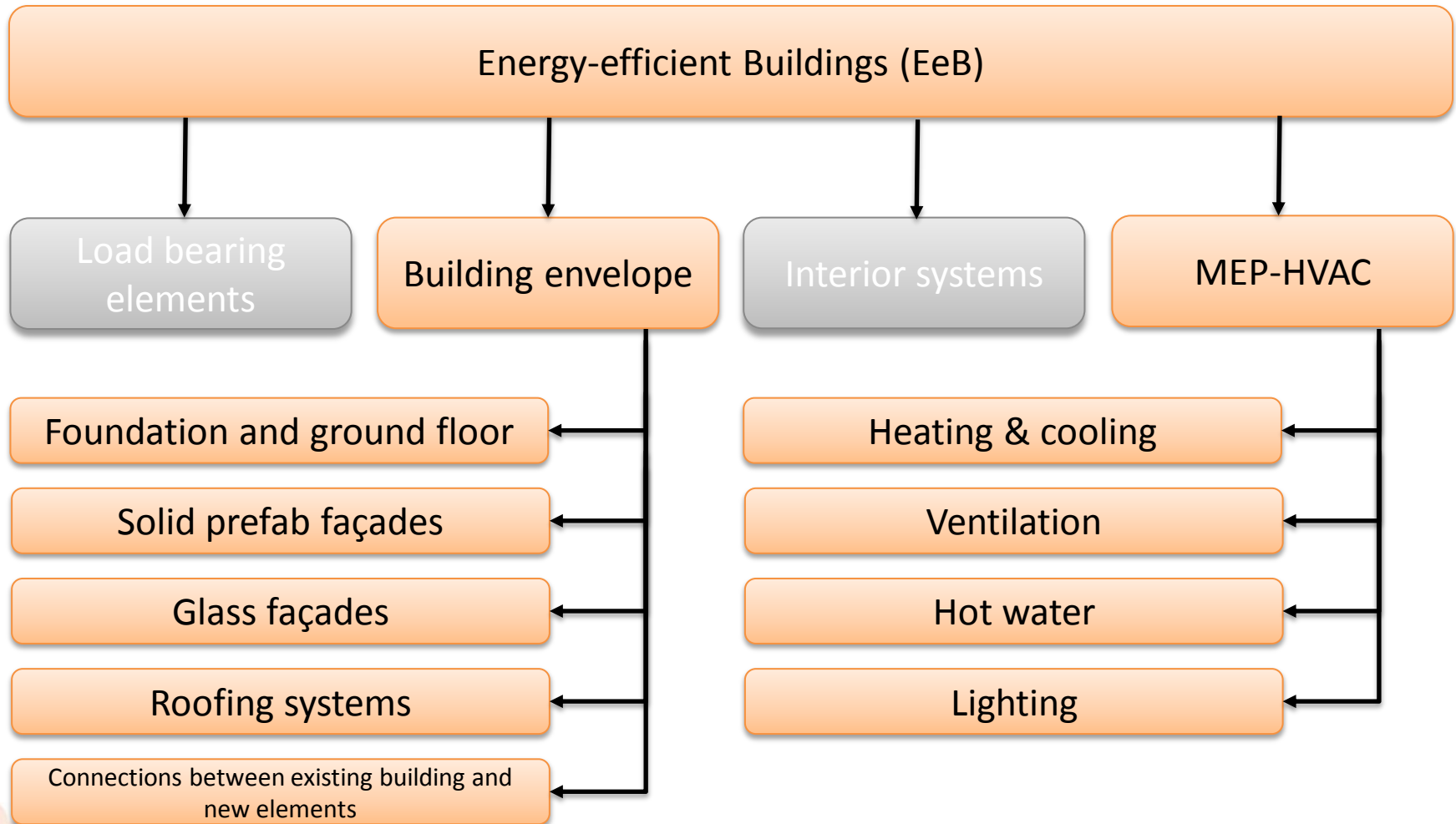


<http://rdf.bg/INSITER/Enschede2/>



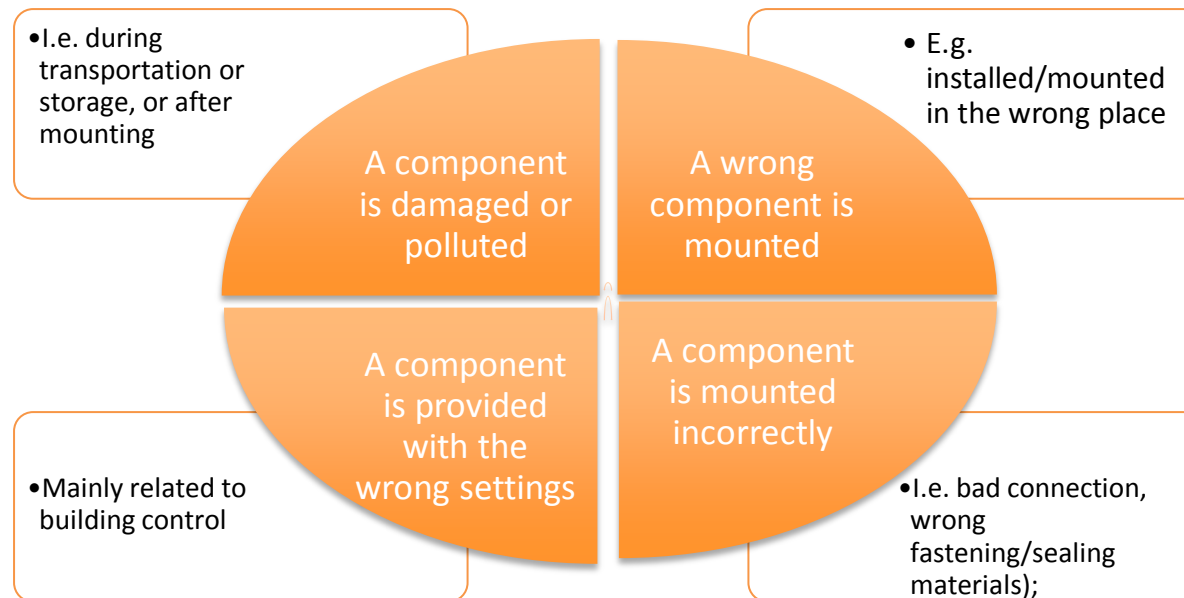
<http://rdf.bg/INSITER/Enschede1/>

SELECTION OF CRITICAL COMPONENTS



COMMON CONSTRUCTION ERRORS

- A shortlist is made of currently existing construction process errors.
- This shortlist is divided into the following categories:



- All currently existing and future to be discovered errors with influence on the energy efficiency and/or environmental quality, can be assigned to a category and solved (prevented) within INSITER

COLLABORATION PLATFORM / GUIDELINES

- **Scope**



----- **Critical EeB Building components**

- Foundation and ground floor
- Exterior walls and built-in elements
- Curtain walls
- Roof
- Connection between new and existing



----- **Critical EeB MEP-HVAC components**

- Heat pump
- Ventilation
- Solar hot water
- LED lighting

COLLABORATION PLATFORM/ GUIDELINES & GUIDELINE APP

- The Guideline app

INSITER Guidelines Explorer

Project Type	Critical Component	INSITER Step
No selection ▼	No selection ▼	No selection ▼

1. Existing | 2. Exterior walls and built-in elements | 1. Mapping

Main critical points:

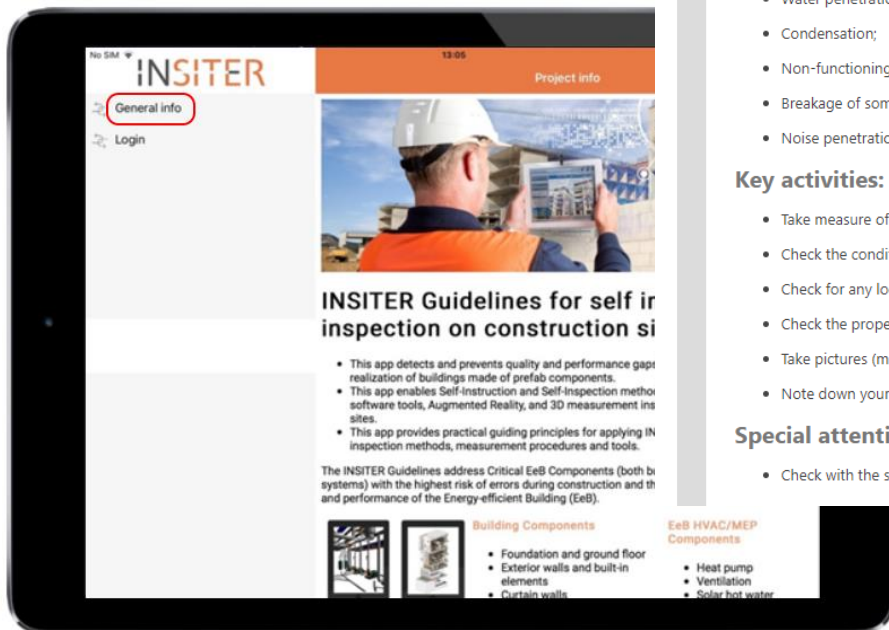
- The presence of any local damages on the horizontal/vertical structure on which the modules will be mounted;
- Air leakages (gaskets, sealings);
- Presence of mold/moisture on the perimeter;
- Water penetration;
- Condensation;
- Non-functioning opening/closing mechanisms (hinges);
- Breakage of some components (glass pane, leaf);
- Noise penetration.

Key activities:

- Take measure of the geometric accuracy to replace the module;
- Check the condition of the opening;
- Check for any local damages on the horizontal/vertical structure on which the modules will be mounted;
- Check the proper set-up of the benchmarking (GPS) for the mounting of the façade elements;
- Take pictures (minimum 3);
- Note down your remarks on the observation panel.

Special attention:

- Check with the site supervisor to perform a quick laser-scanning of the existing conditions.



COLLABORATION PLATFORM / GUIDELINES

INSITER Guidelines

1. Used by:

- Construction worker, Project Manager, Site supervisor
- Inspection Expert, Building Owner, End user
- BIM people, Architects, structural engineers, MEP/HVAC engineers

2. INSITER Guideline is future oriented:

- Bridge from research to practical implementation
- Interactive digital guidelines through mobile and desktop applications



COLLABORATION PLATFORM / GUIDELINES

The Guidelines in the app

- Main critical components
- Key activities
- Special attention

INSITER Guidelines Explorer

Project Type	Critical Component	INSITER Step
2. New-built ▼	6. Heat pump system ▼	2. Checking ▼

1. Existing | 2. Exterior walls and built-in elements | 1. Mapping

Main critical points:

- The presence of any local damages on the horizontal/vertical structure on which the modules will be mounted;
- Air leakages (gaskets, sealings);
- Presence of mold/moisture on the perimeter;
- Water penetration;
- Condensation;
- Non-functioning opening/closing mechanisms (hinges);
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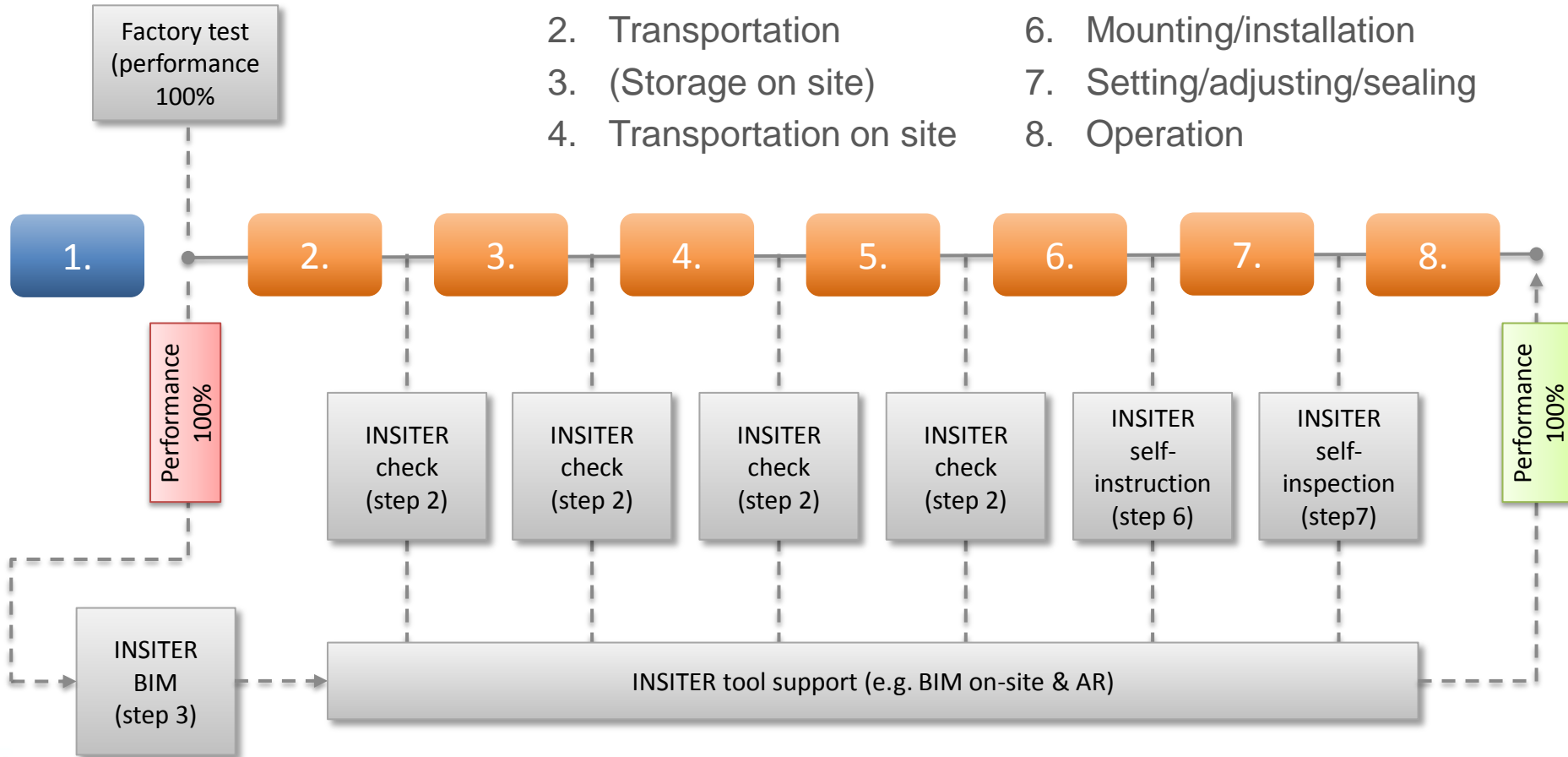
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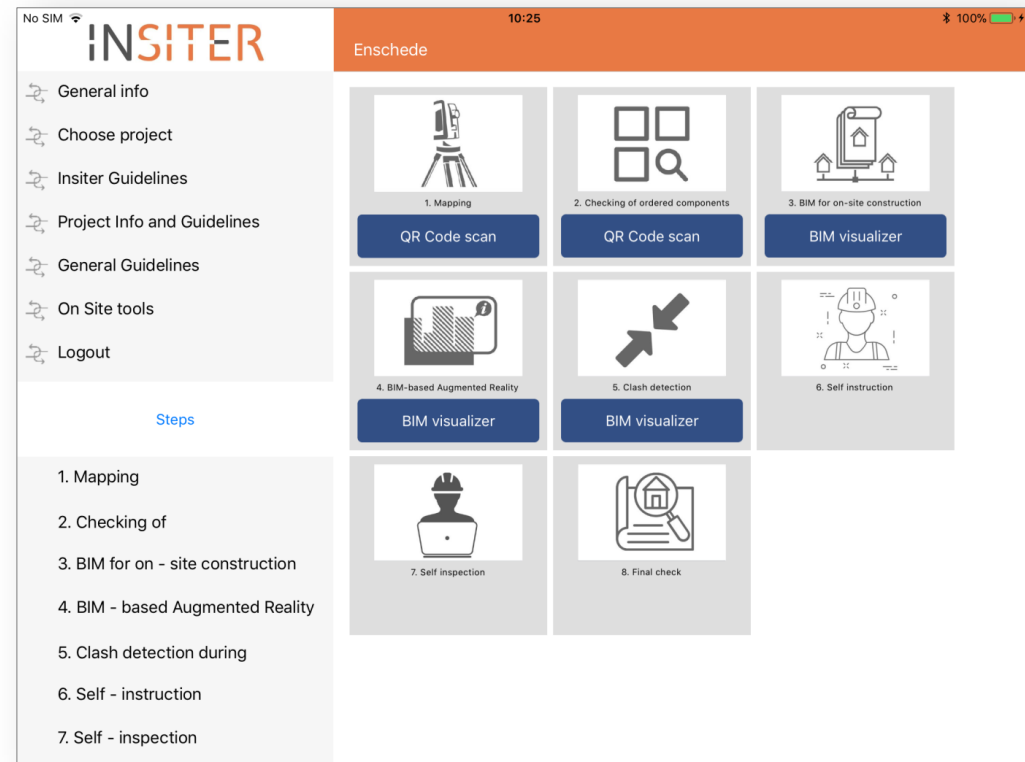
ADDING GUIDELINES FOR (NEW) COMPONENTS

1. Manufacturing
2. Transportation
3. (Storage on site)
4. Transportation on site
5. (Storage on location)
6. Mounting/installation
7. Setting/adjusting/sealing
8. Operation



COLLABORATION PLATFORM/ RE ON SITE APP

- Reading the QR-code or RFID-chip
- Peer reviewing construction results
- Identifying shortcomings during construction
- Checklist preparation
- Checking construction results
- Processing self-inspection results
- Defining follow up actions



8-STEP INSITER METHOD -- FOR THE WORKER

STEP 1: Mapping

Identify the real environment on-site, where the work should be performed

STEP 3: BIM on site

Deploying BIM on construction site

STEP 5: Clash Detection

Verification of the current site situation

STEP 7: Self-Inspection

Verify the current application or installation and fill in checklists for further processing



STEP 2: Checking

Check delivered components against design by using QR-Code for identification and verification

STEP 4: BIM based AR

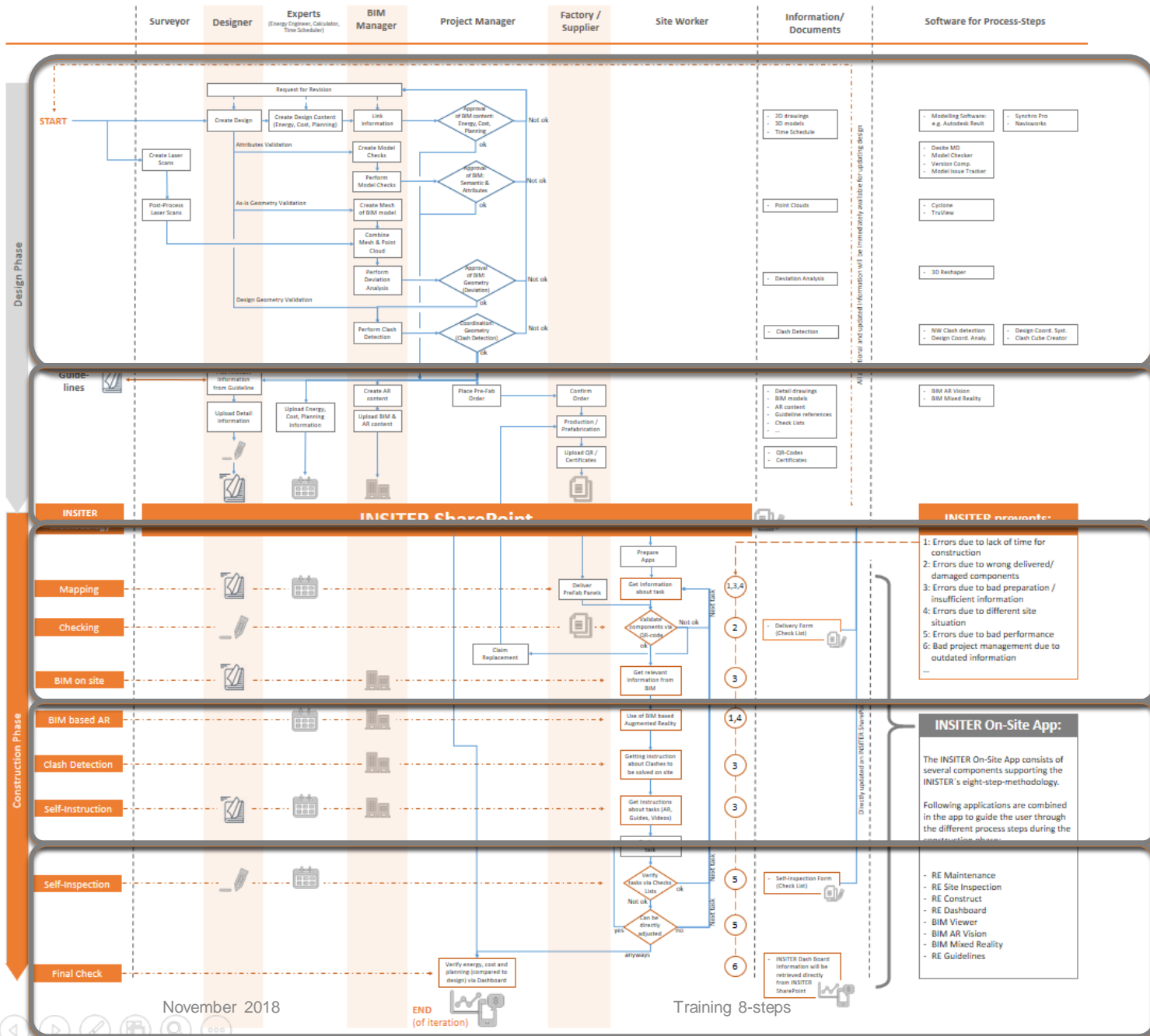
Validate delivered elements against design requirements

STEP 6: Self-Instruction

Guiding the construction process using a mobile device

STEP 8: Final Check

Quality, time and cost evaluation by the Construction Managers



Validating Design and approval for Upload

Providing Input and placement of Prefab-Order

Briefing the Site-Worker & Validating Components on site

Self-Instruction of the site-worker

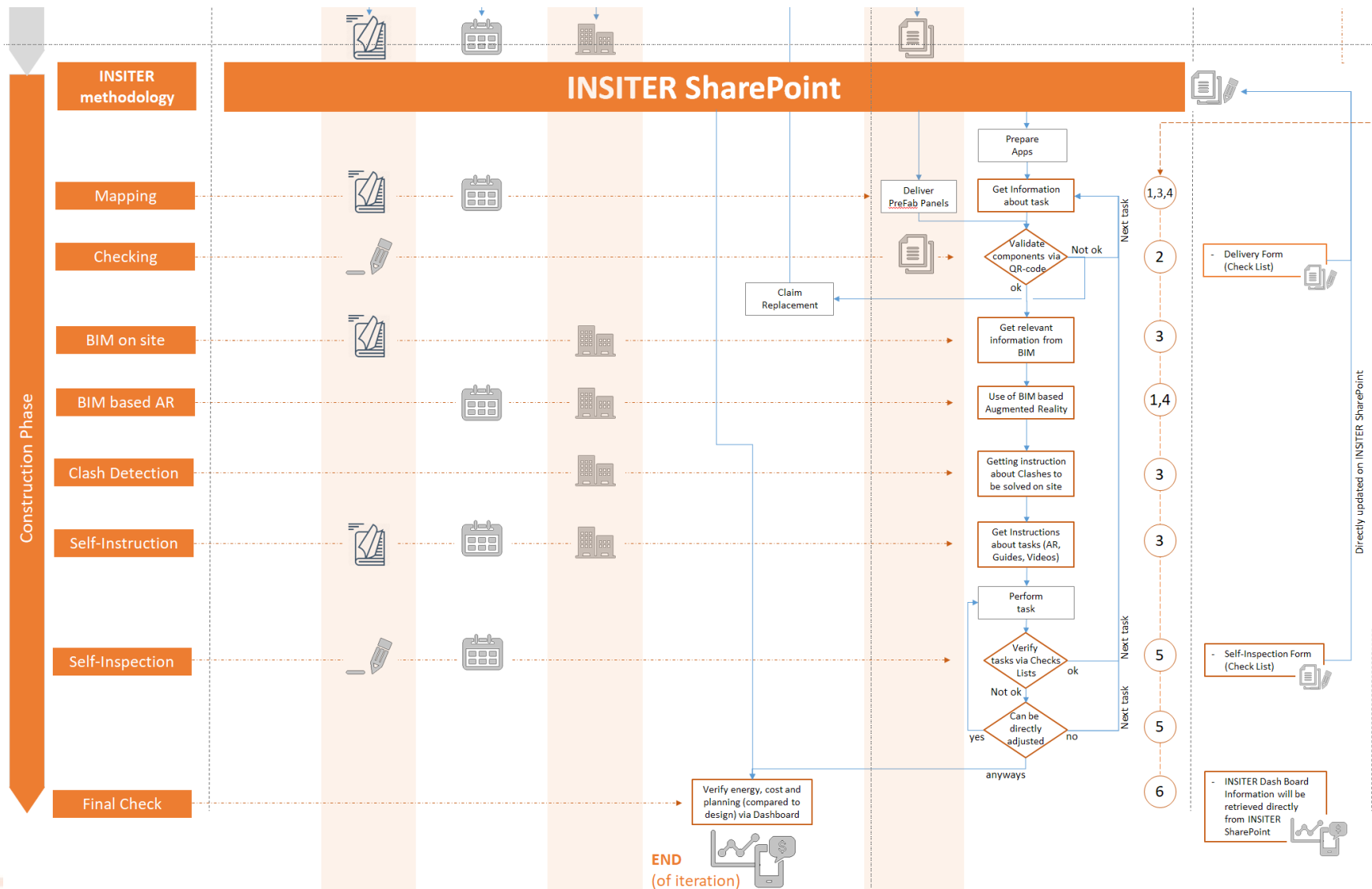
Validating the results & analyzing the Project

GUIDANCE ON IMPLEMENTATION FOR EACH OF THE 8-STEPS

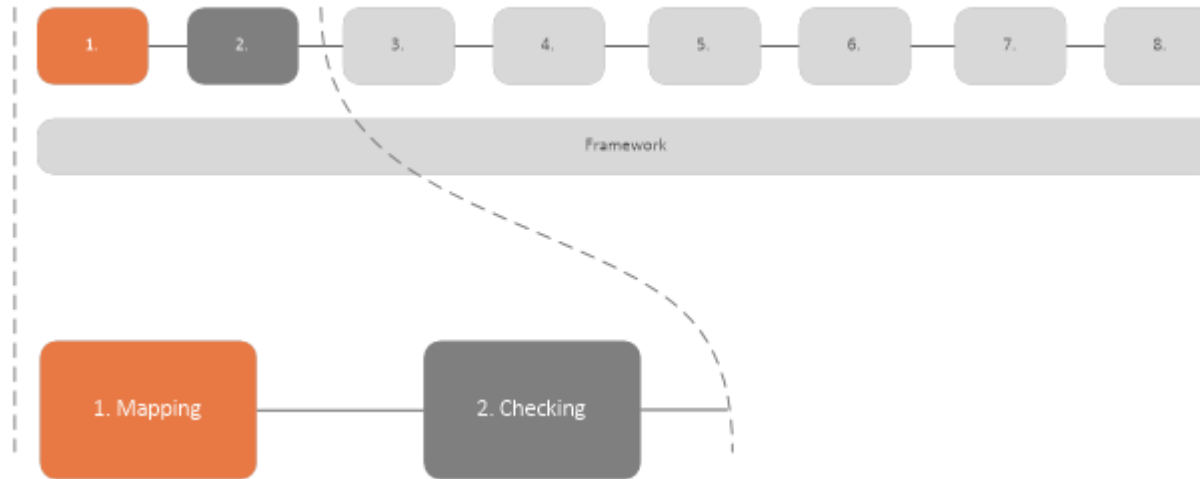
- Explanation of the step both for:
 - Off-site (preparation)
 - On-site (execution)
- Actors involved in the step
- Actual application of the step
- Qualifications related to the step



8-STEP METHOD -- GUIDING IMPLEMENTATION OF QA



STEP 1 - MAPPING



Actual conditions of the construction site



STEP 1 - MAPPING

Design

Creating geometric and semantic inventories of an existing building in a refurbishment scenario



- **Laser Scanning (on-site)**
 - Acquire the geometrical data on the building by laser scanning techniques (on site)
 - Process 3D point clouds
 - Provide 3D point clouds for performing a deviation analysis



November 2018



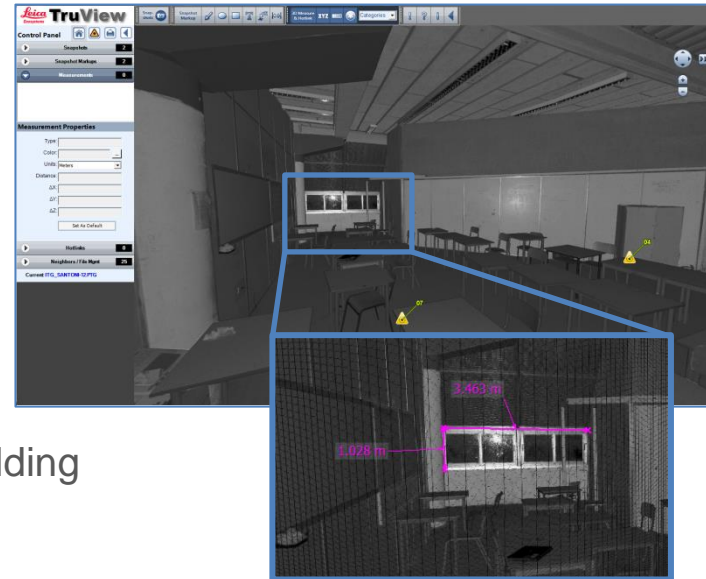
Training 8-steps

STEP 1 - MAPPING

Tools:

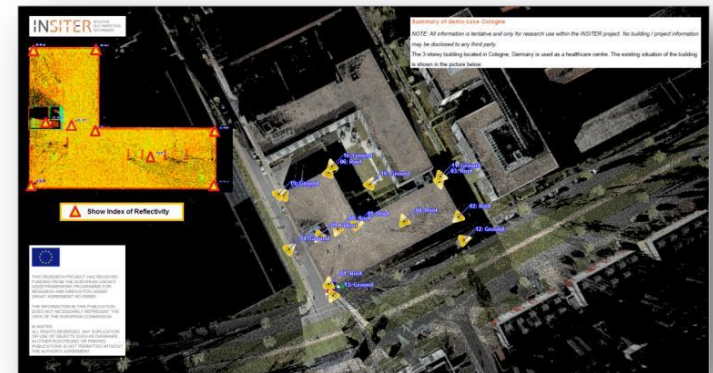
On-site:

- **RE Maintenance**
 - Tool for the condition assessment of a building



Off-site

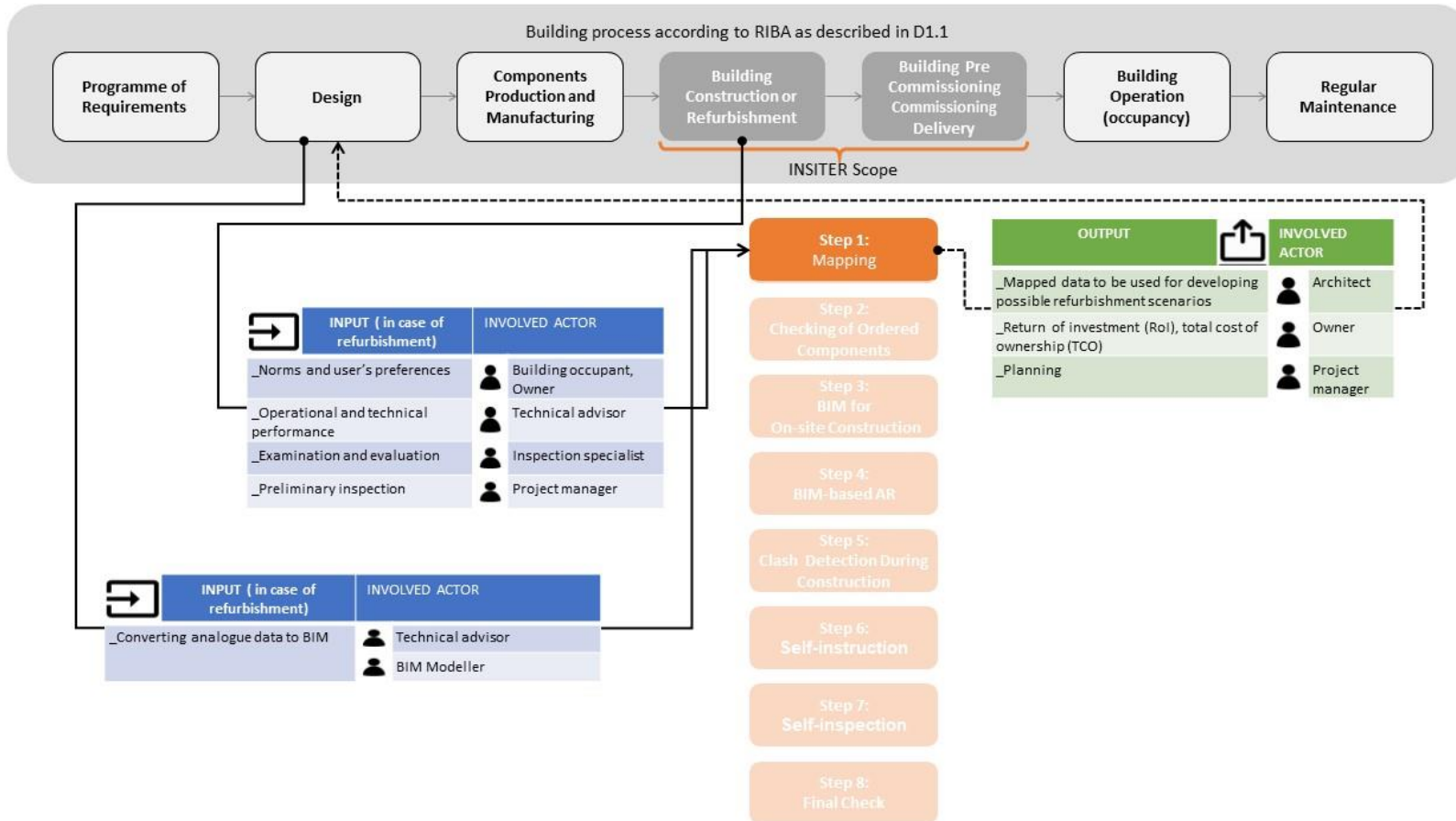
- **Cyclone**
 - Point cloud processing software
- **TruView**
 - Visualizing the point clouds
- **3DReshaper**
 - Post-processing tool for the 3D laser scanner
 - Also used for deviation analysis and modelling
- **Design Coordination System**
 - Software to coordinate geometrical conflicts to speed up the process of coordination





STEP 1 – MAPPING- ACTORS

Design



STEP 1 MAPPING- QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS



INSITER step	INSITER description	Task name	Delivery	SUB-task name(s)
1	Mapping actual technical conditions of the site and building, and performing economic valuation of the property and land; capture the requirements and compare them to as-is situation	Map actual technical conditions of the site and building	Deliver 2D/3D drawings (latest IFC BIM model)	1.1
		Perform economic valuation of the property and land	Perform geometric checking of the building Deliver a usable 3-D scan to the architect for BIM	1.2
		Capture the requirements and compare them to as-is situation	Deliver: verification of the deviations of the existing concrete structure which influence the thermal performance of the new prefabricated panels	1.3



STEP 1 MAPPING- QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS



1. Mapping

Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
1.1. Building owner			Deliver 2D/3D drawings (latest IFC BIM model)
1.2 3D-scanner	How to work with 3-D laserscanning; understanding pointcloud data processing	The parts of the 3-D laserscan (areas of interest) of the facade, which are relevant for replacement with prefabricated panels	Perform geometric checking of the building Deliver a usable 3-D scan to the architect for BIM
1.3 Building engineer			Deliver: verification of the deviations of the existing concrete structure which influence the thermal performance of the new prefabricated panels



STEP 1 – MAPPING FOR FAÇADE ELEMENTS

From design to construction

Target: Identify the correct working area for façade elements



1. Mapping

The Story behind:

After starting the INSITER app and getting his work assignment, the site-worker begins the work by mapping the location where to place the façade elements.

Screenshots:



CONTROL OF BEARING CONSTRUCTION

- Dimensional problems with bearing construction (outside the accepted tolerances).
- Construction problems with the bearing construction.
- Bearing construction not flat, square or straight

STEP 1 – MAPPING PREFAB BUILDING

From design to construction

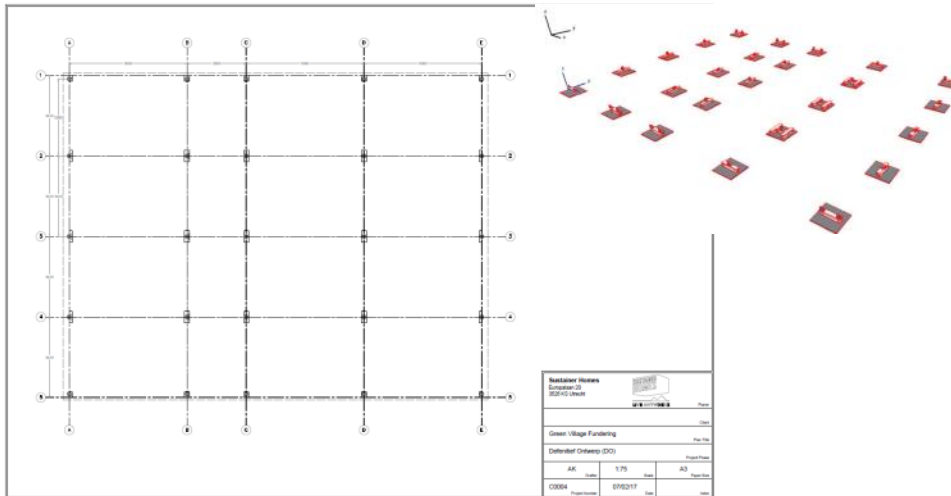
Target: Identify the correct working area



The Story behind:

The modules of a prefab building will be placed on steel bearers.
The steel bearers are placed in advance on the exact position and height by using laser scanning.

Screenshots:





1. Mapping

- Project Green Village, Delft



<https://www.youtube.com/watch?v=gmuwNWFTuNs&feature=youtu.be>



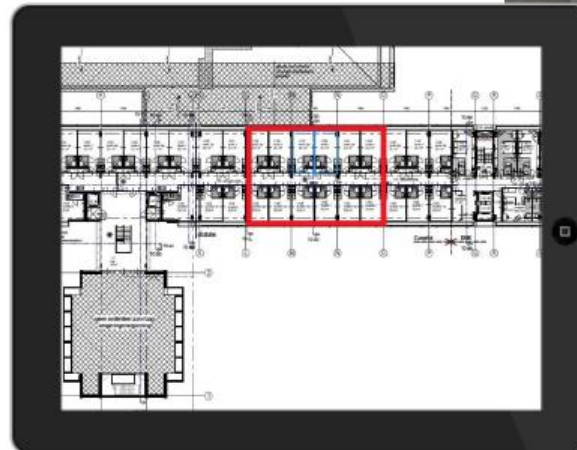
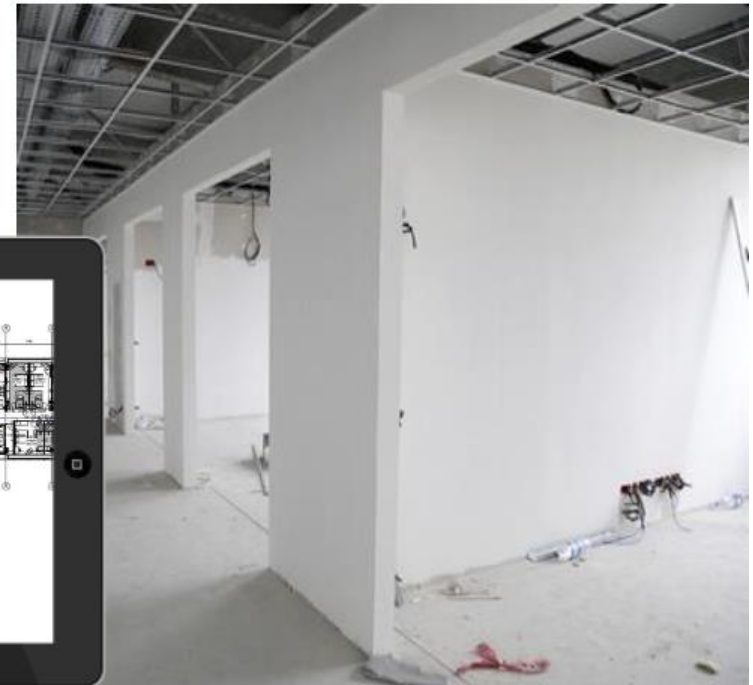
INSITER GUIDELINES



- **INSITER guidelines timeline for the construction worker**

Step 1: Mapping

The construction worker in this step needs to capture the conditions and to compare them with the as-is situation. He goes to the location and he makes a preliminary evaluation of the actual conditions on site. He can retrieve reference material for main energy-efficient and quality construction errors to be checked.



NEW GUIDELINE STEP 1 – MAPPING

New critical EeB component: ...

...



INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

Key activities

Special attention

Technical information

E.g.:

- Completeness of bearing structure or connecting components
- Geometrical accuracy of the structure
- Surrounding environment is clear of obstructions
- ...

E.g.:

- Check condition of structure or connecting components
- Check for local damages and debris
- Check if benchmark is set up
- ...

E.g.:

- In case of inaccuracies, check with the supervisor if additional research or action (e.g. measurements) is needed
- ...

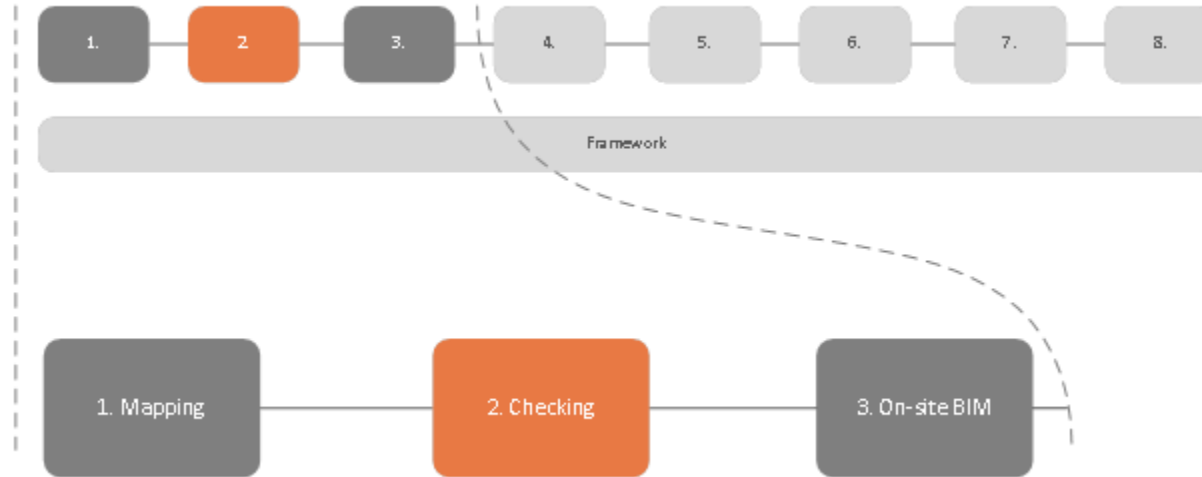
E.g.:

- Site plan for location of component
- Information on requirements for the assembling location of the component
- ...





STEP 2 - CHECKING



Self-inspection

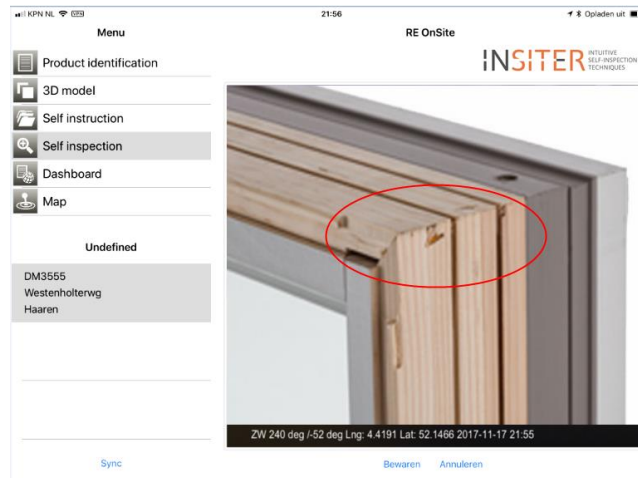
- during purchasing, production and delivery
- ### Checking of prefab ordered components





STEP 2 - CHECKING

Ensuring building components comply to specification and are undamaged delivered on-site



STEP 2 - CHECKING

Check delivered components against design by using QR-Code or RFID chip for identification and verification



Story

The components to be installed/applied are delivered on the building site. Using QR or RFID scanning tool, the construction worker checks whether these are the correct components as specified in the BIM model and technical documents.

- ✓ Right components in right condition (no damages)
- ✓ Right connection material, in right condition and quantity.

Screenshots



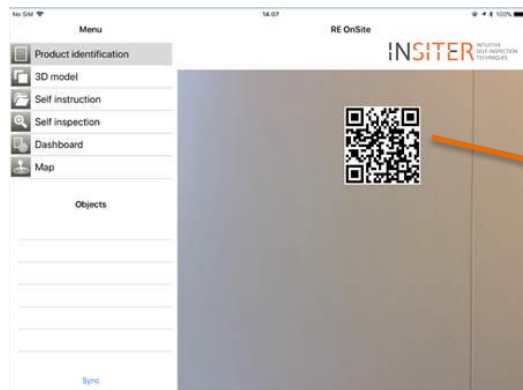
STEP 2 CHECKING - TOOLS 1/2



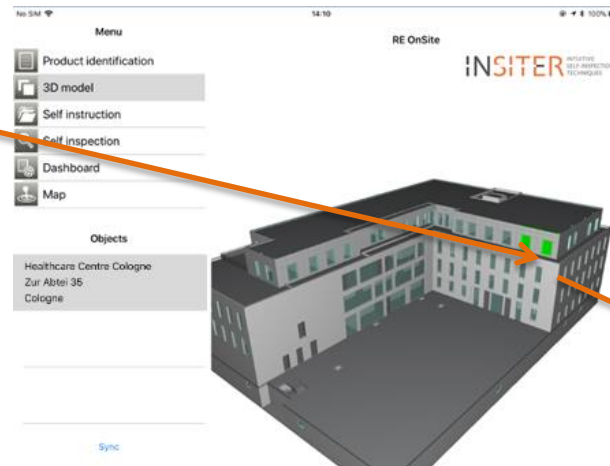
QR reader and digital checklist

As part of the checking process a QR reader has been developed for the identification of the goods delivered on-site and to quickly navigate to the associated part on the 3D BIM model for which a digital checklist is available.

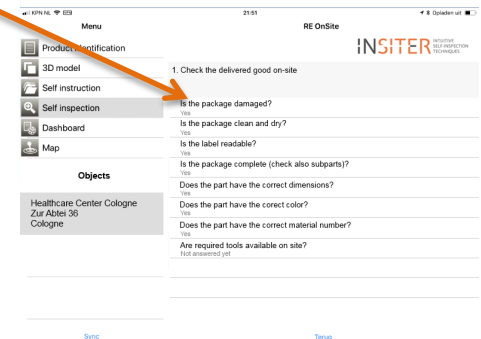
QR reader



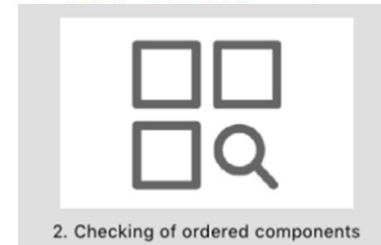
3D viewer



Checklist incoming goods



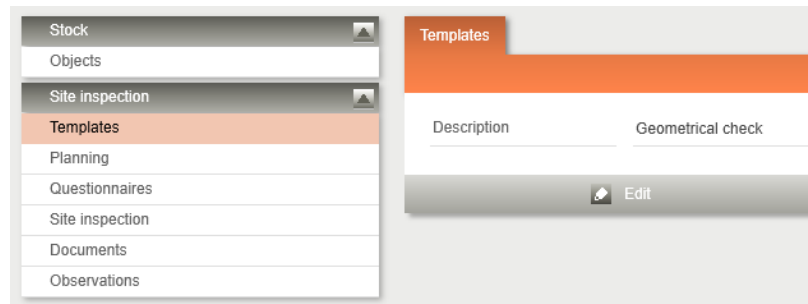
STEP 2 CHECKING - TOOLS 2/2



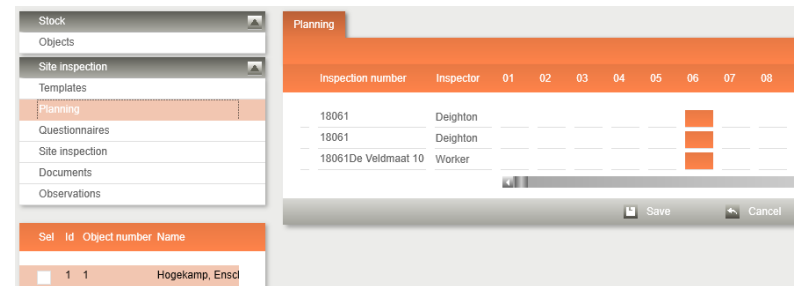
Digital Checklists templates

Checklist templates can be made in Excel and uploaded into the Site inspection system
From these templates checklists can be instantiated for a certain part of the building

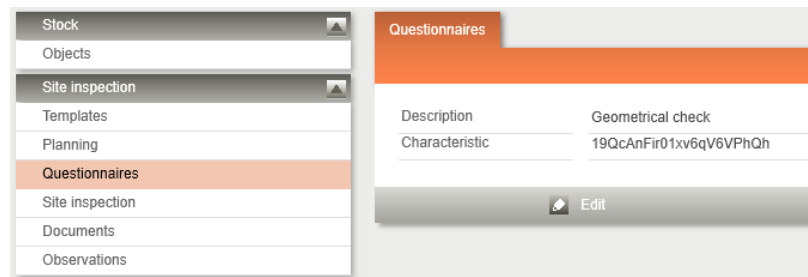
1. Upload a checklist template



3. Plan the inspection and assign to a person



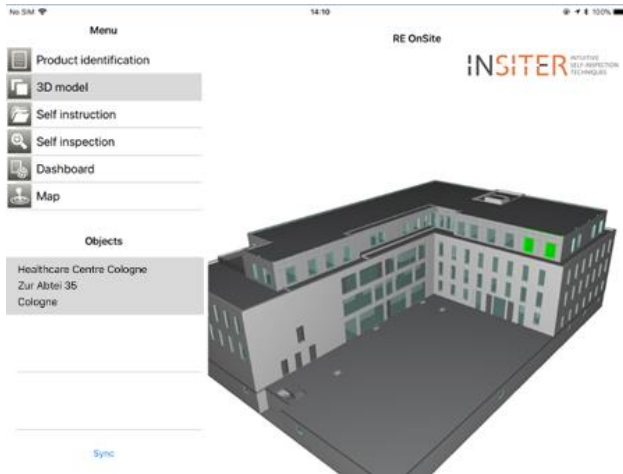
2. Checklist per element by supplying GUID



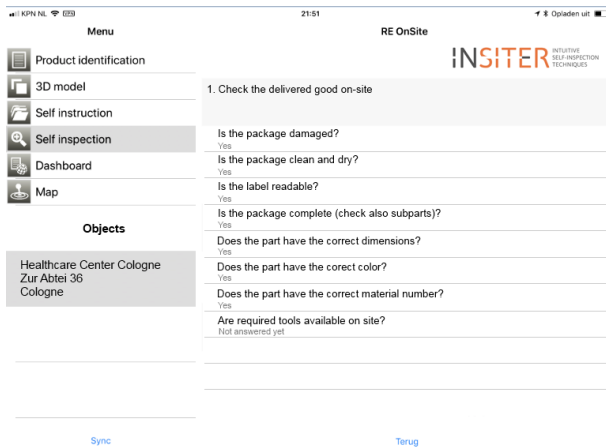
4. Checklist ready for on-site inspections



STEP 2 QR CODE SCANNING

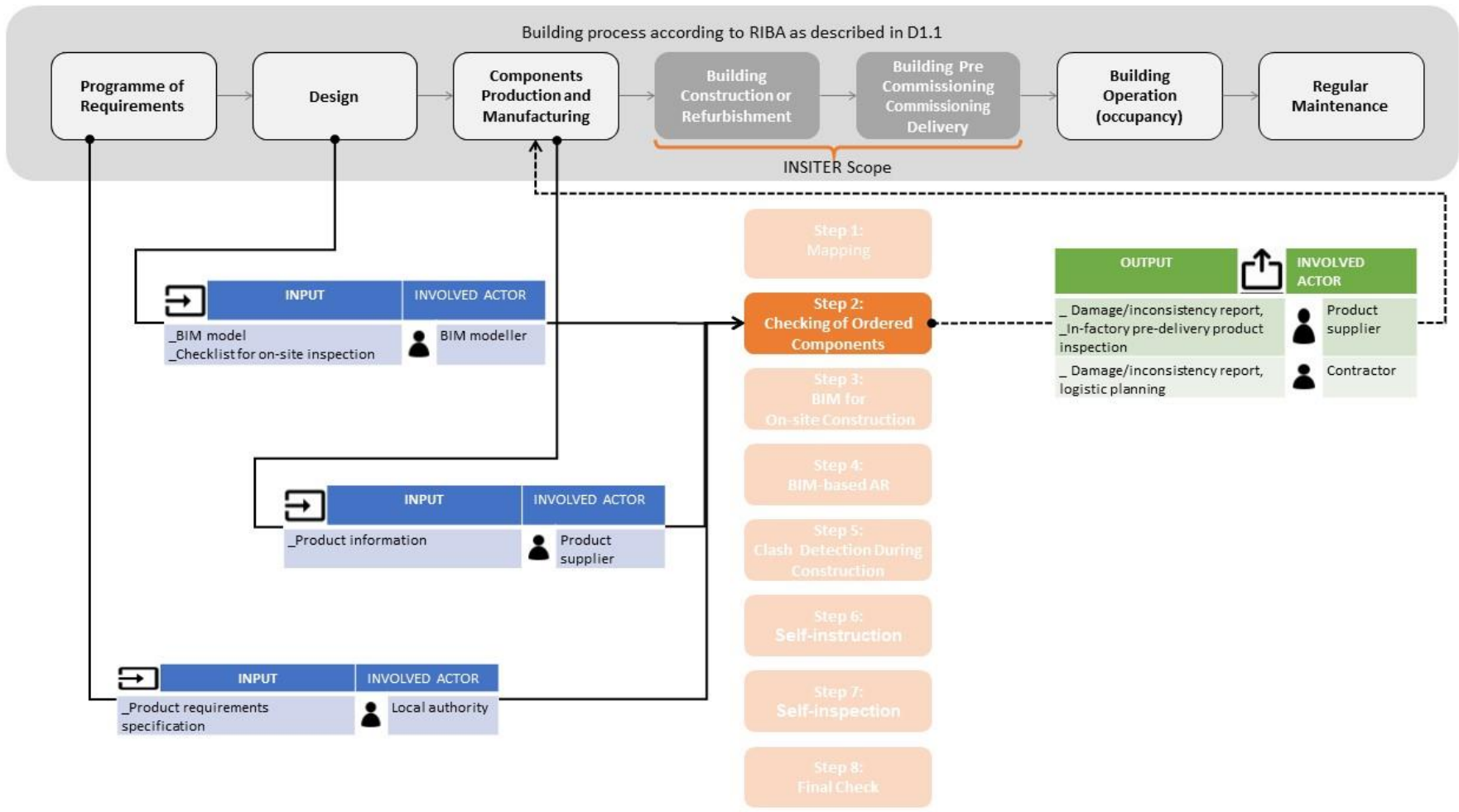


App shows model and highlights corresponding building element information about planned location “this specific component has to be Installed here”



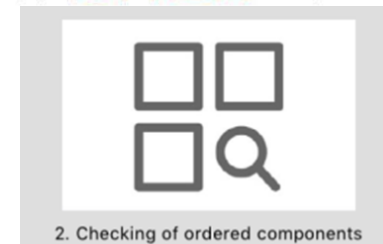
All information related to that element (documents, checklists, images, videos) are available on INSITER’s SharePoint site further processing

STEP 2 CHECKING – ACTORS



STEP 2 CHECKING – QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS



	INSITER description	Task name	SUB-task name(s)	
2	Self-inspection at procurement, production and delivery of prefab components	Self-inspect at procurement	Order the prefabricated panels according to planning	2.1
		Self-inspect at production	Add the right QR-code to the prefabricated panels	2.2
		Self-inspect at delivery	Transport the prefabricated panels by using the QR-code to the right position with tablet and BIMmodel	2.3

Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
Building site manager			Order the prefabricated panels according to planning
Production worker factory			Add the right QR-code to the prefabricated panels
Construction worker	Where to store and install the prefabricated panel according to the BIM-model; how to work with the QR-code	The correct storing place of the prefabricated panels gives an organised building process (by using the QR-code)	Transport the prefabricated panels by using the QR-code to the right position with tablet and BIMmodel



STEP 2 - CHECKING

Target: Provide site-worker with information how to check the correctness of the ordered components

The Story behind:

The façade elements to be mounted are delivered on the building site. Using QR or RFID scanning tool, the construction worker checks whether these are the correct components as specified in the BIM model and technical documents.

- Right modules in right condition (no damages) and no deformations
- Right connection material, in right condition and quantity.

Screenshots:





STEP 2 - CHECKING

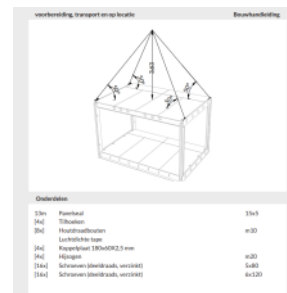
Target: Provide site-worker with information how to check the correctness of the ordered components

The Story behind:

The 16 modules for the office are stored on-site.
The connecting material and finishing were stored in the modules.

Right modules in right condition (no damages)
Right connection material, in right condition and quantity

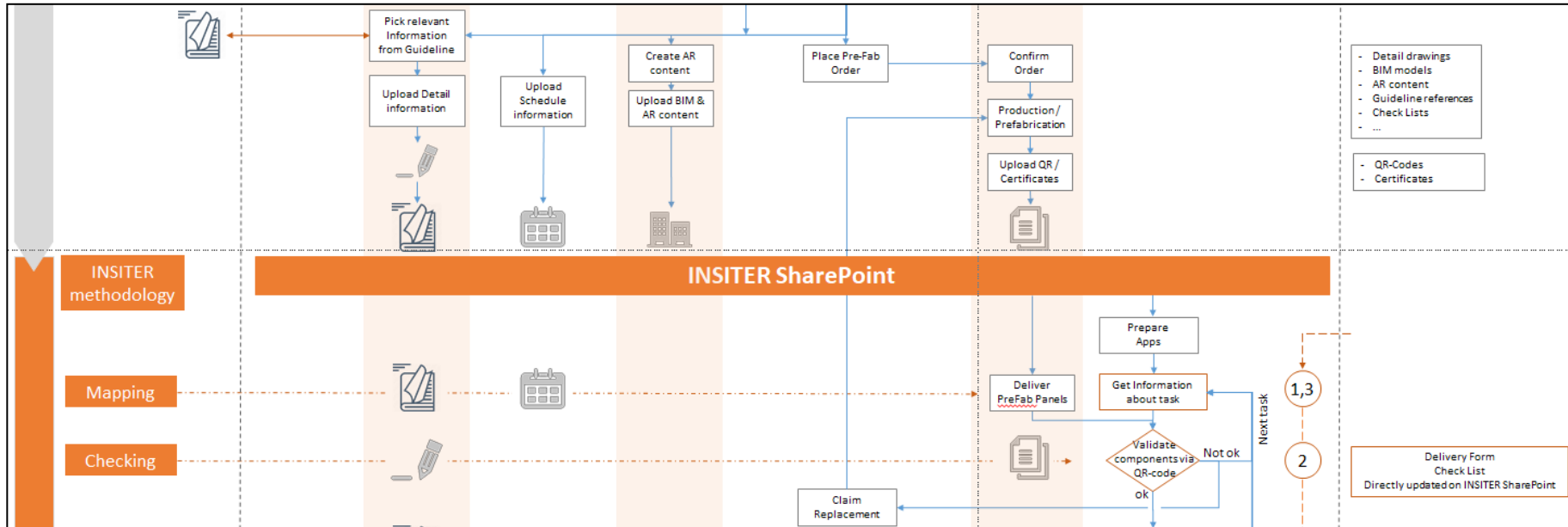
Screenshots:





STEP 2 CHECKING BUILDING PROCESS

Check delivered components against design by using QR-Code for identification and verification



NEW GUIDELINE STEP 2 – CHECKING OF COMPONENTS

New critical EeB component: ...

...

Step 1:
Mapping

Step 2:
Checking of Ordered
Components

Step 3:
BIM for On-site
Construction

Step 4:
BIM-based AR

Step 5:
Clash Detection
during Construction

Step 6:
Self-instruction

Step 7:
Self-inspection

Step 8:
Final Check

INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

E.g.:

- Consistency of components
- To ensure that delivered components comply to the specifications.
- To ensure components are free of damages.
- ...

Key activities

E.g.:

- Identification of the component (using QR).
- Confirmation of correct component and specification
- Check if component is free of damages.
- ...

Special attention

E.g.:

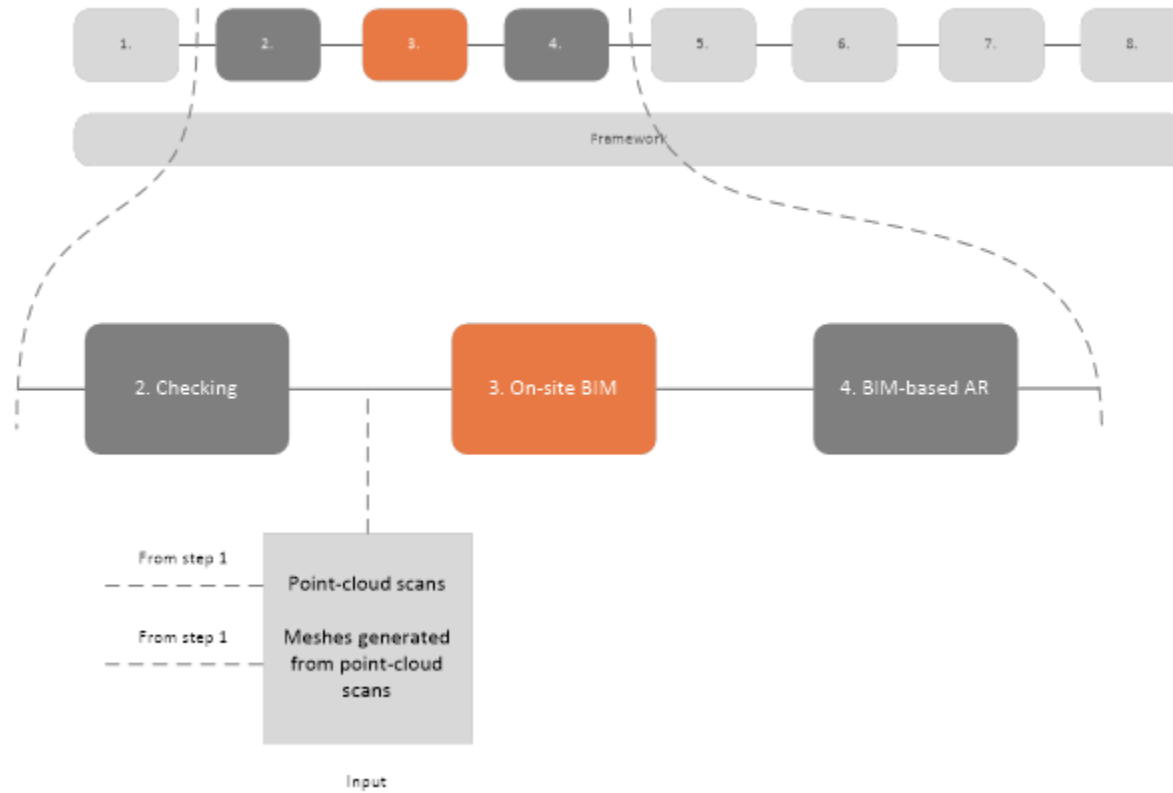
- Check completeness of the delivered components.
- Retrieve information about storage and transportation on site.
- ...

Technical information

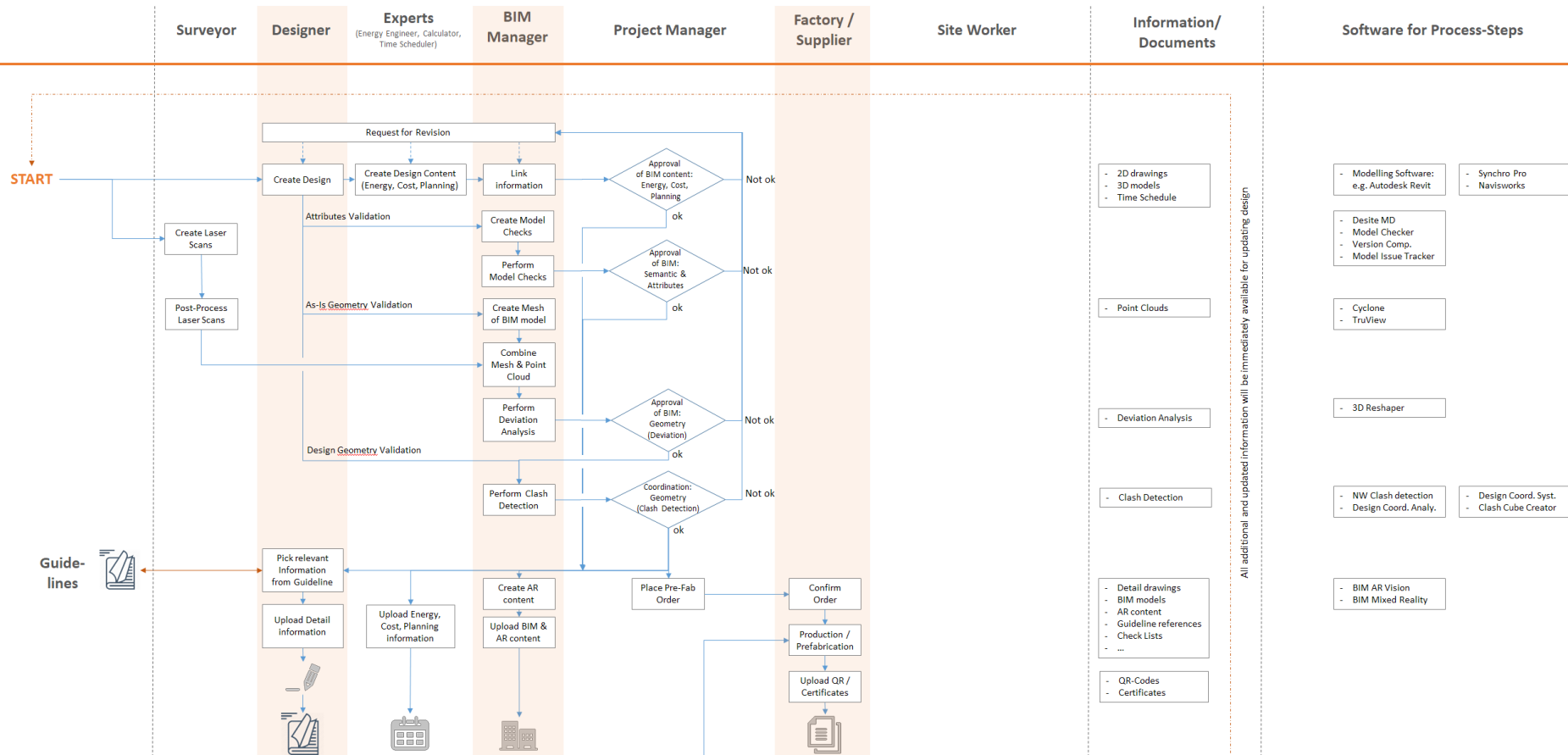
E.g.:

- Technical data and specification of the component (PDF)
- Manual for transportation and storage (PDF)
- ...

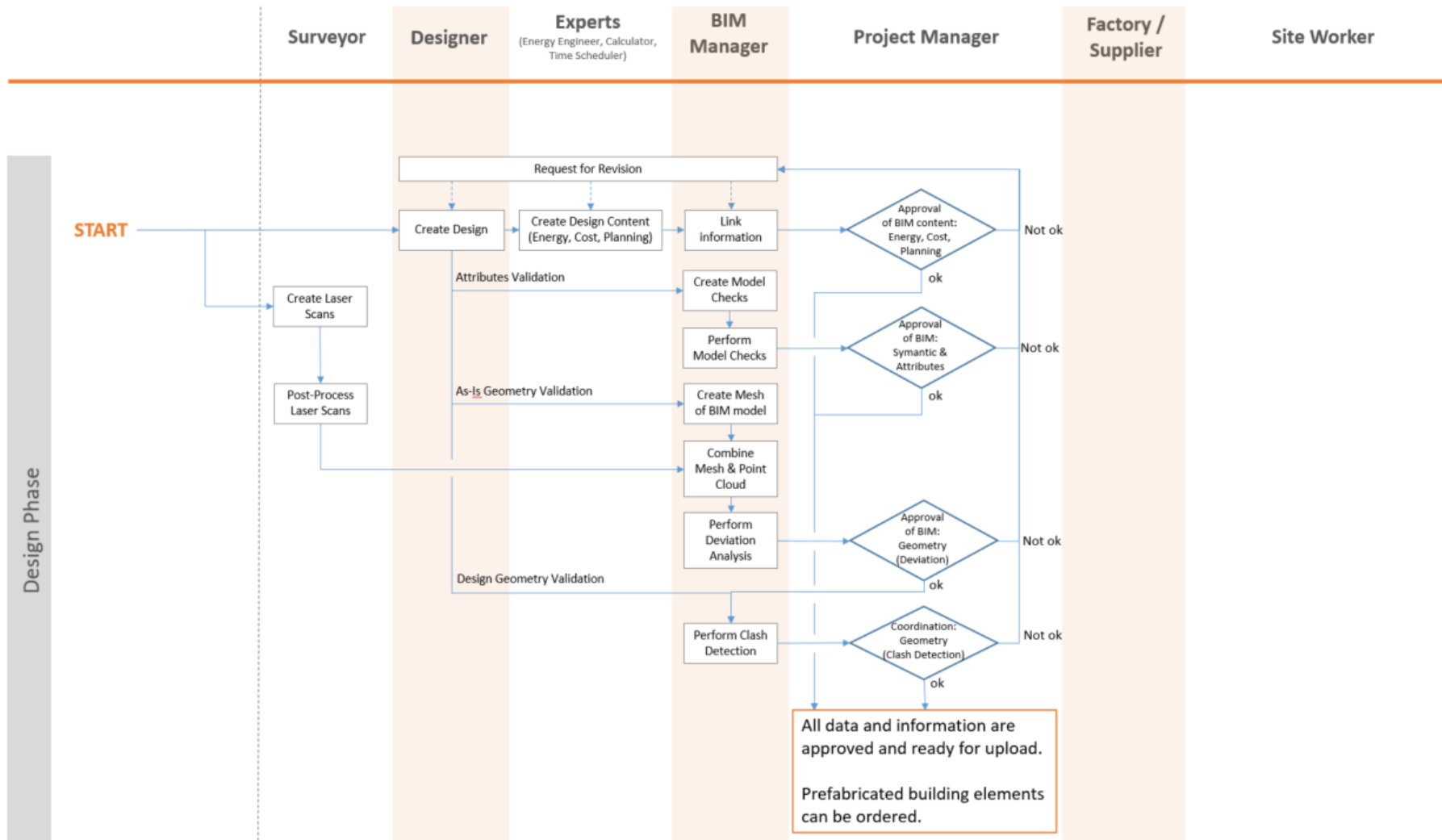
STEP 3 – ON-SITE BIM



8-STEP METHOD -- FOUNDATION NEEDED



VALIDATING DESIGN AND APPROVAL FOR UPLOAD



STEP 3 – ON-SITE BIM



3. BIM for on-site construction

Modelling and preparing BIM-models for on-site usage

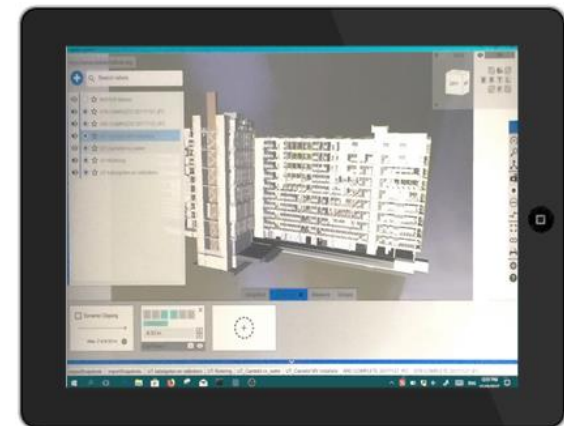


STEP 3 – ON-SITE BIM



For:

- BIM-managers
- Architects, project managers and contractors with a degree of BIM-knowledge



STEP 3 – ON-SITE BIM

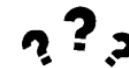


Situation:

Communication and requirements are:

- Often quite different
- Leading to miscommunication
- Multiple (separate) BIM-models used by various parties

“It takes less time to start all over again, then using a BIM-model which I don’t trust or is incomplete”





3. BIM for on-site construction

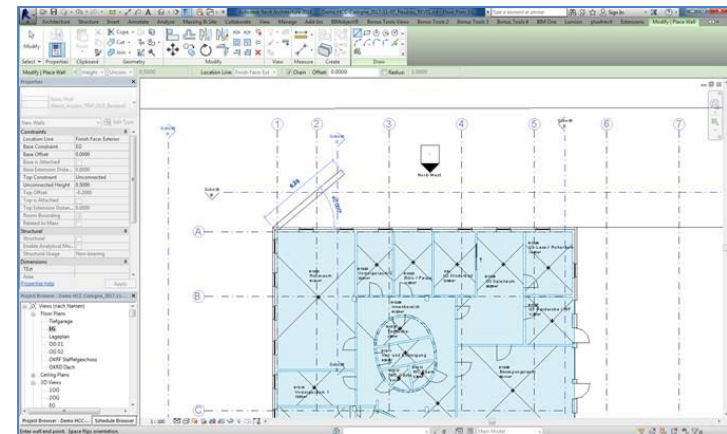
STEP 3 – ON-SITE BIM

Integral vision of INSITER:

- ✓ Ensuring BIM-model is suitable for (on-site) usage
- ✓ Visualization
- ✓ Planning and scheduling
- ✓ Cost estimation

Purpose:

Make relevant aspects of the BIM-model available for the construction worker



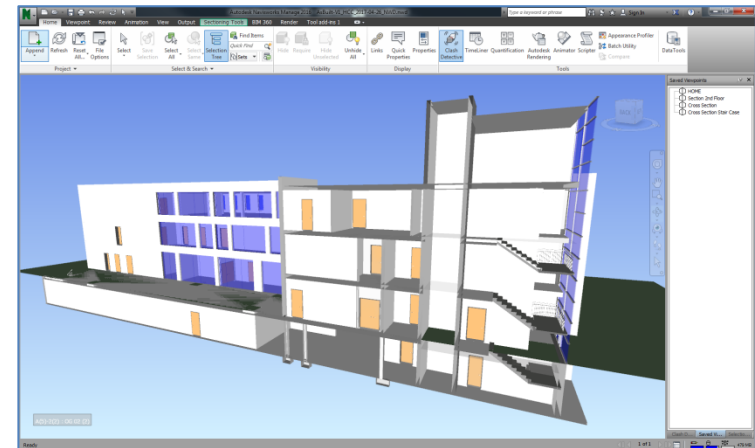
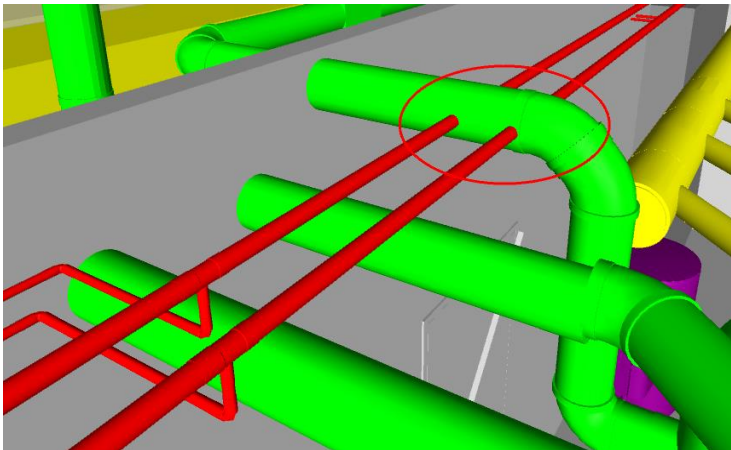
STEP 3 – ON-SITE BIM



BIM-modelling: Revit

BIM-model suitable for (on-site) usage:

- Navisworks Manage for clash detection
- Ceapoint Desite MD for model checks
- Issue tracker, validation tool

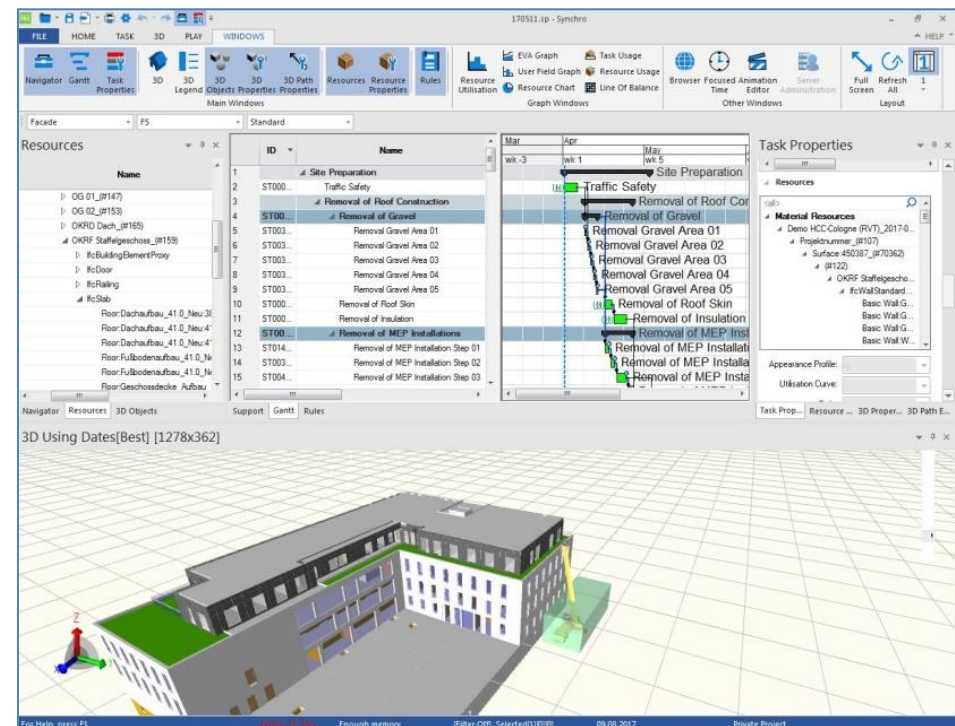


STEP 3 – ON-SITE BIM



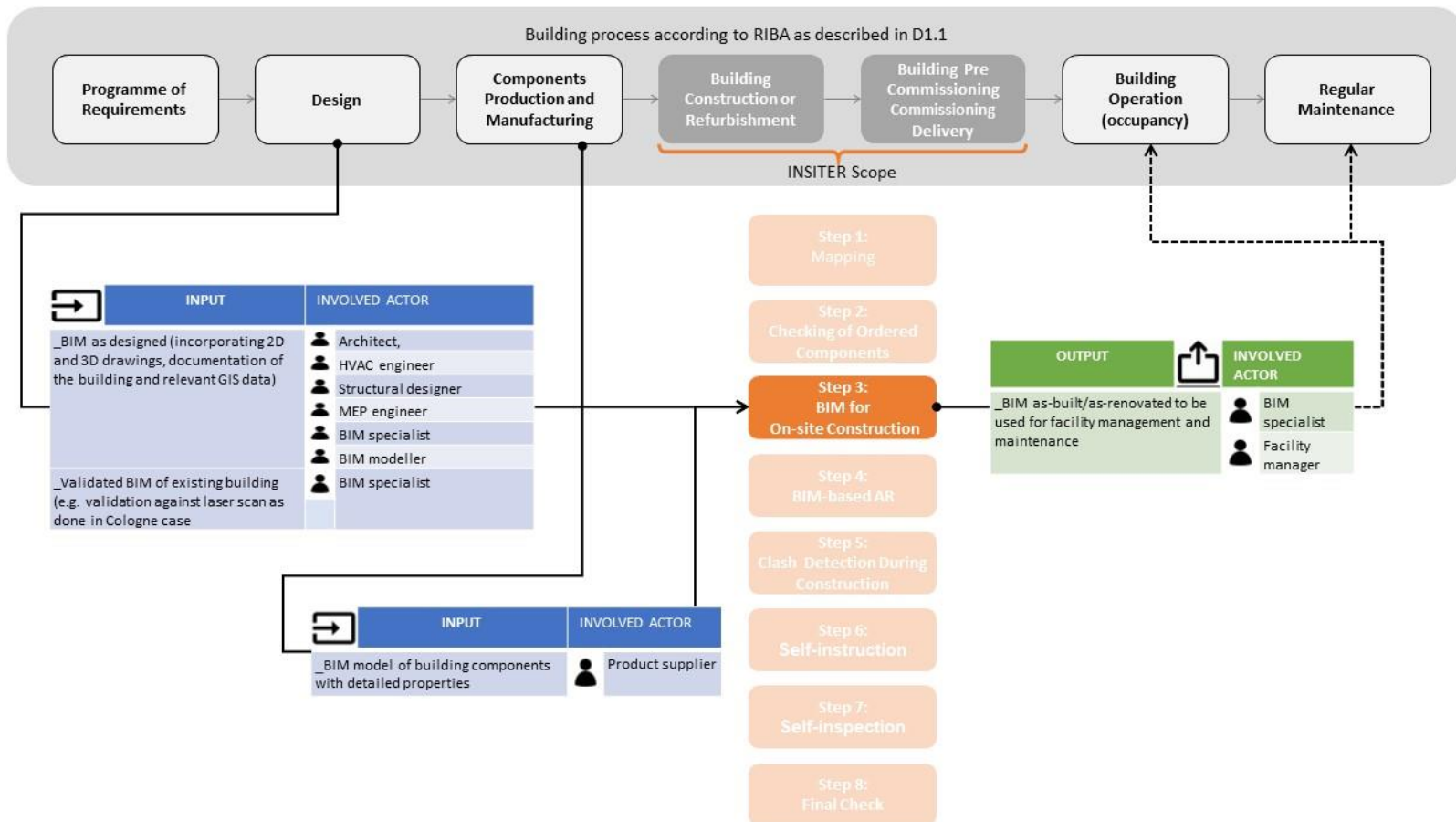
Planning and scheduling:

- 'Time' is added via Synchro PRO
- Work Breakdown structure
- 4-D simulation as an animation file
- Cost estimation: CostOS





STEP 3 – ON-SITE BIM – ACTORS



STEP 3 ON SITE BIM – QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS



INSITER step	INSITER description	Task name		SUB-task name(s)
3	Modelling of the [existing] building, site and surroundings in Building Information Model (BIM).	Model the [existing] building in Building Information Model (BIM).	Deliver a design for an energie-efficiënt façade	3.1
			Deliver an engineered design for an energie-efficiënt façade without thermal bridges	3.2
			Deliver HVAC installation design, according to the new façade with wished indoor climate	3.3
			Design according to the input of architect/ building physicist, building regulations	3.4



STEP 3 ON SITE BIM – QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS



Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
3.1 Architect			Deliver a design for an energie-efficiënt façade
3.2 Building physicist			Deliver an engineered design for an energie-efficiënt façade without thermal bridges
3.3. Designer HVAC			Deliver HVAC installation design, according to the new façade with wished indoor climate
3.4 BIM-designer	How to engineer a façade with prefabricated panels, building regulations	Connections between façade and the adjacent parts of the building, thermal bridges	Design according to the input of architect/ building physicist, building regulations



STEP 3 – ON-SITE BIM

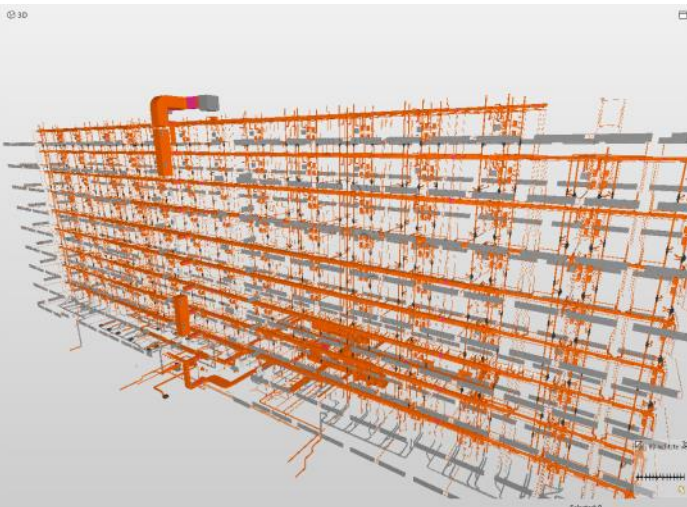
Target: Deploying BIM on construction site



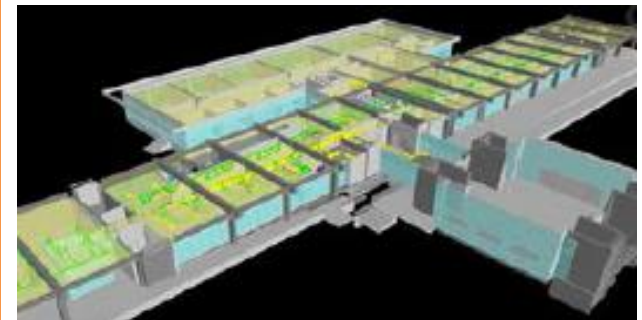
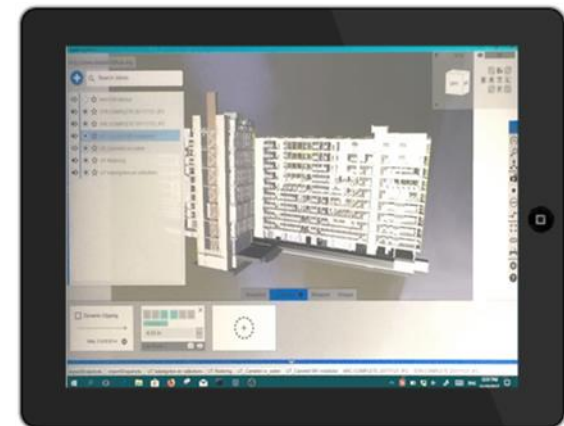
3. BIM for on-site construction

The Story behind:

Using his mobile device, the construction worker opens the BIM model of the specific part of the building where he has to mount the façade elements or MEP-systems



Screenshots:



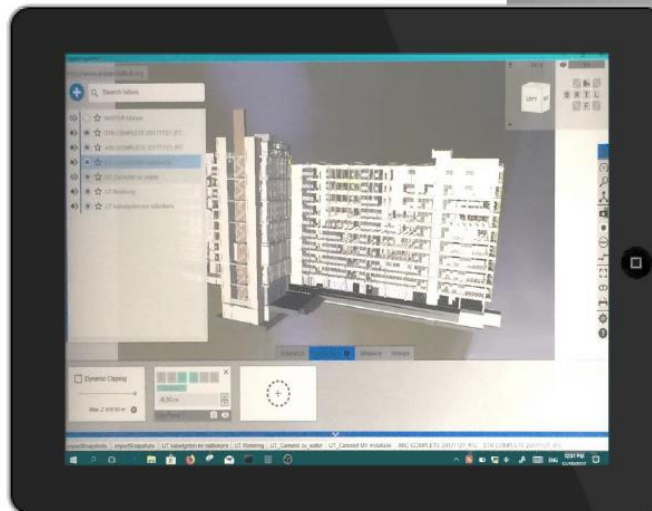
INSITER GUIDELINES



- **INSITER guidelines timeline for the construction worker**

Step 3: BIM for on-site construction

Visualization of the building or the critical EeB components in BIM. Using the mobile device, the construction worker opens the BIM model of the specific part of the building where he has to perform his work.





3. BIM for on-site construction

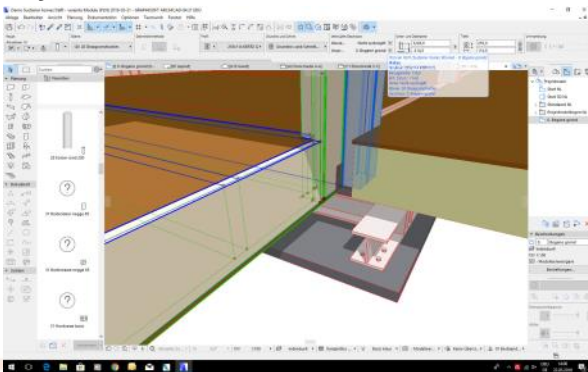
STEP 3 – ON-SITE BIM

Target: Visualisation in BIM for on-site use

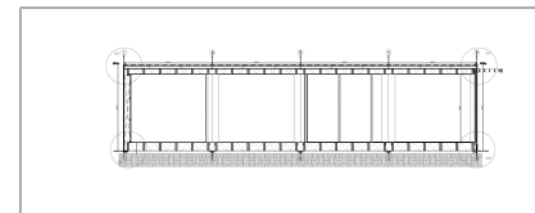
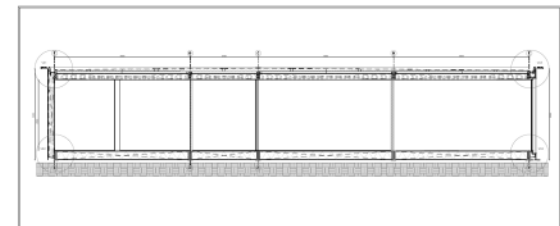
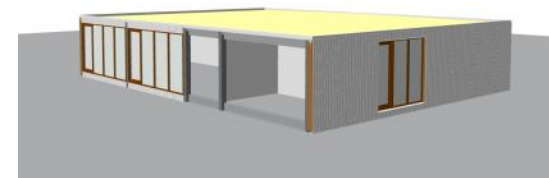
The Story behind:

3D-model was made by INSITER based on 2D drawings of Sustainer Homes.
The BIM-model was not used on-site.

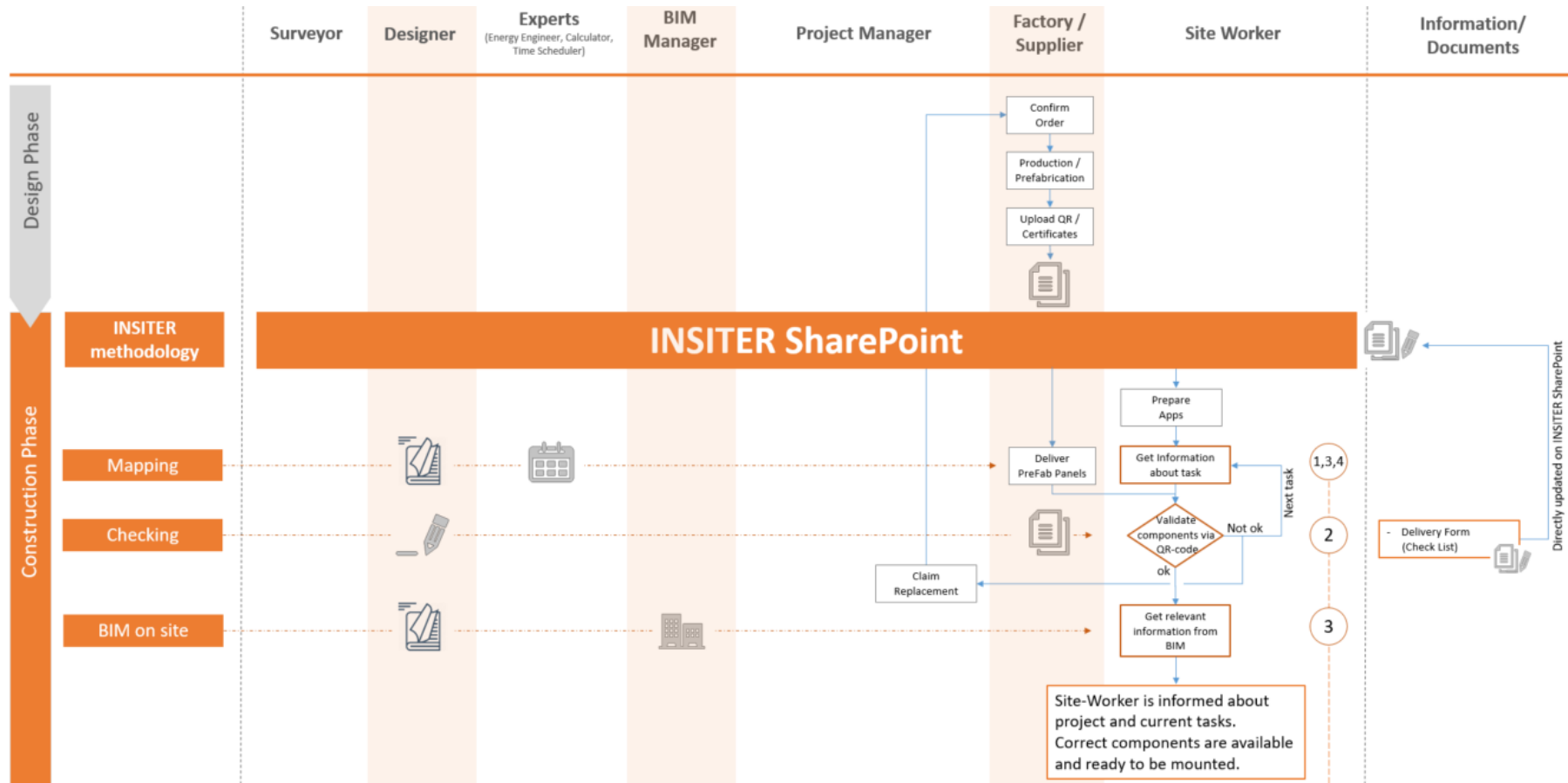
Depending of the level of detail additional information can be added to the model for the exact position of the airtight layers



Screenshots:



BRIEFING THE SITE-WORKER & VALIDATING COMPONENTS ON SITE



INSITER prevents:

- 1: Errors due to lack of time for construction
- 2: Errors due to wrong delivered / damaged components
- 3: Errors due to bad preparation / insufficient information
- 4: Errors due to different site situation
- 5: Errors due to bad performance
- 6: Bad project management due to outdated information

NEW GUIDELINE STEP 3 – BIM FOR ON-SITE CONSTRUCTION

New critical EeB component: ...

...



INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

Key activities

Special attention

Technical information

E.g.:

- Latest version of the design available
- BIM model of the component integrated in BIM of the building
- ...

E.g.:

- Embed the component BIM model in the building BIM model
- Use the BIM model on the BIM viewer to observe how the component is modelled

E.g.:

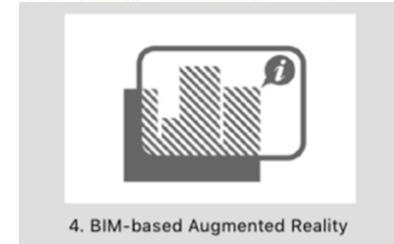
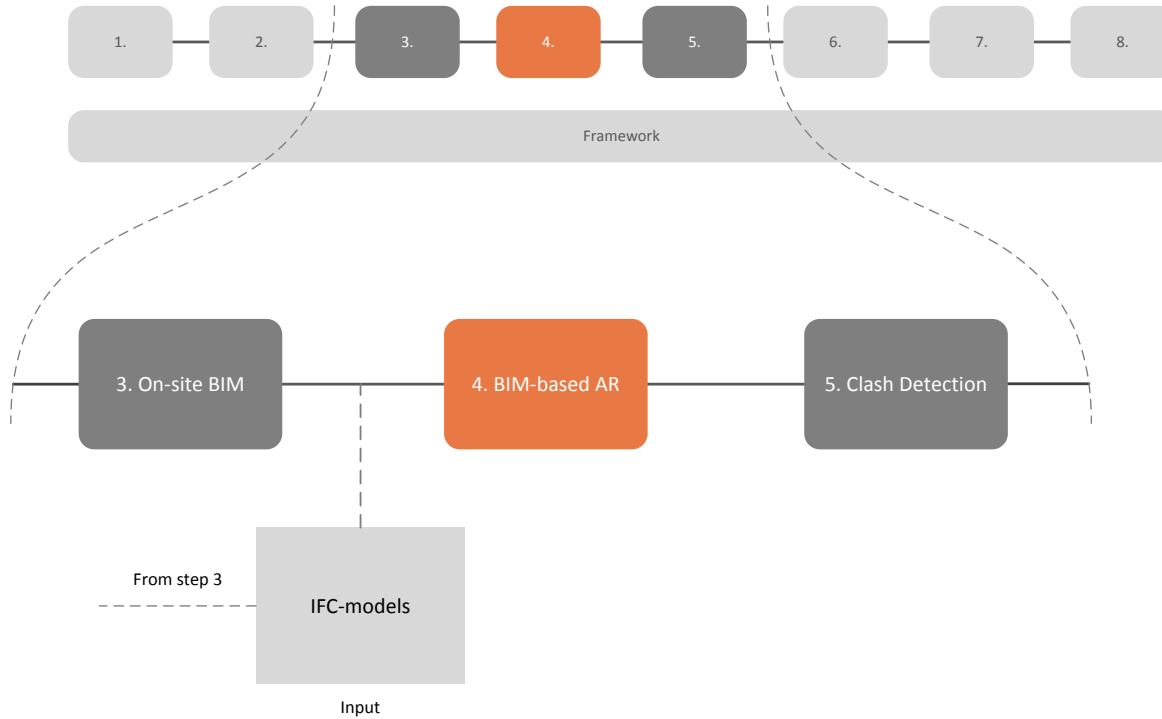
- ...

E.g.:

- BIM model of the component
- Example BIM connections

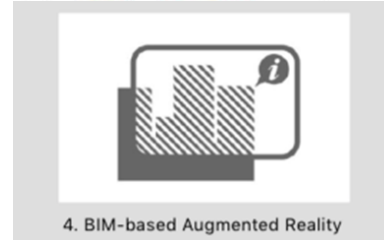


STEP 4 – BIM-BASED AR



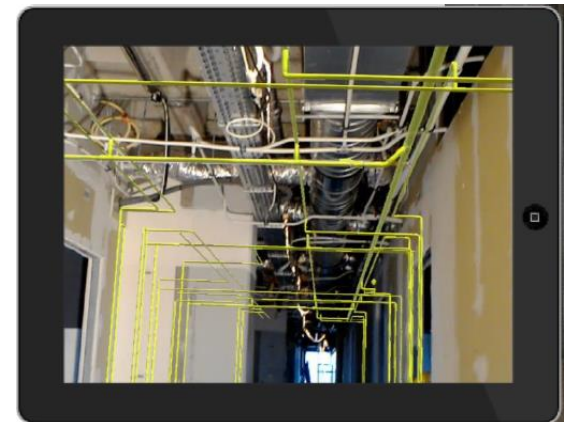
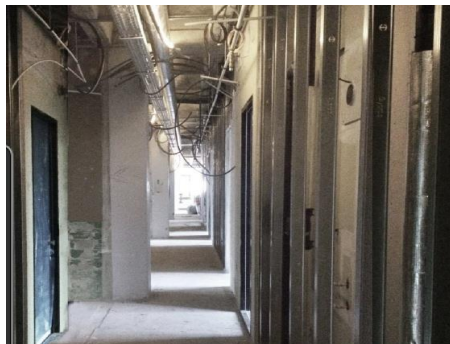
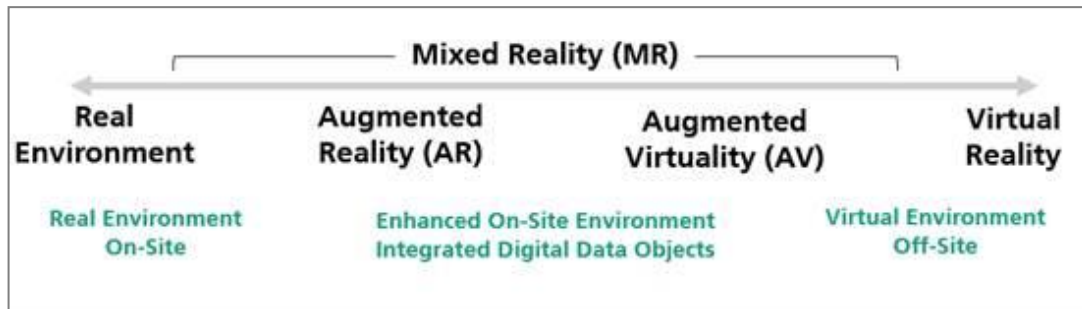
Developments for self-instruction and self-inspection

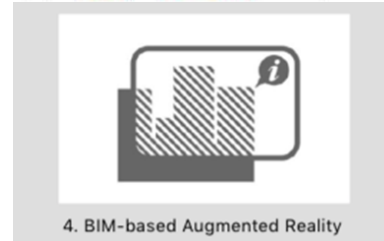




STEP 4 – BIM-BASED AR

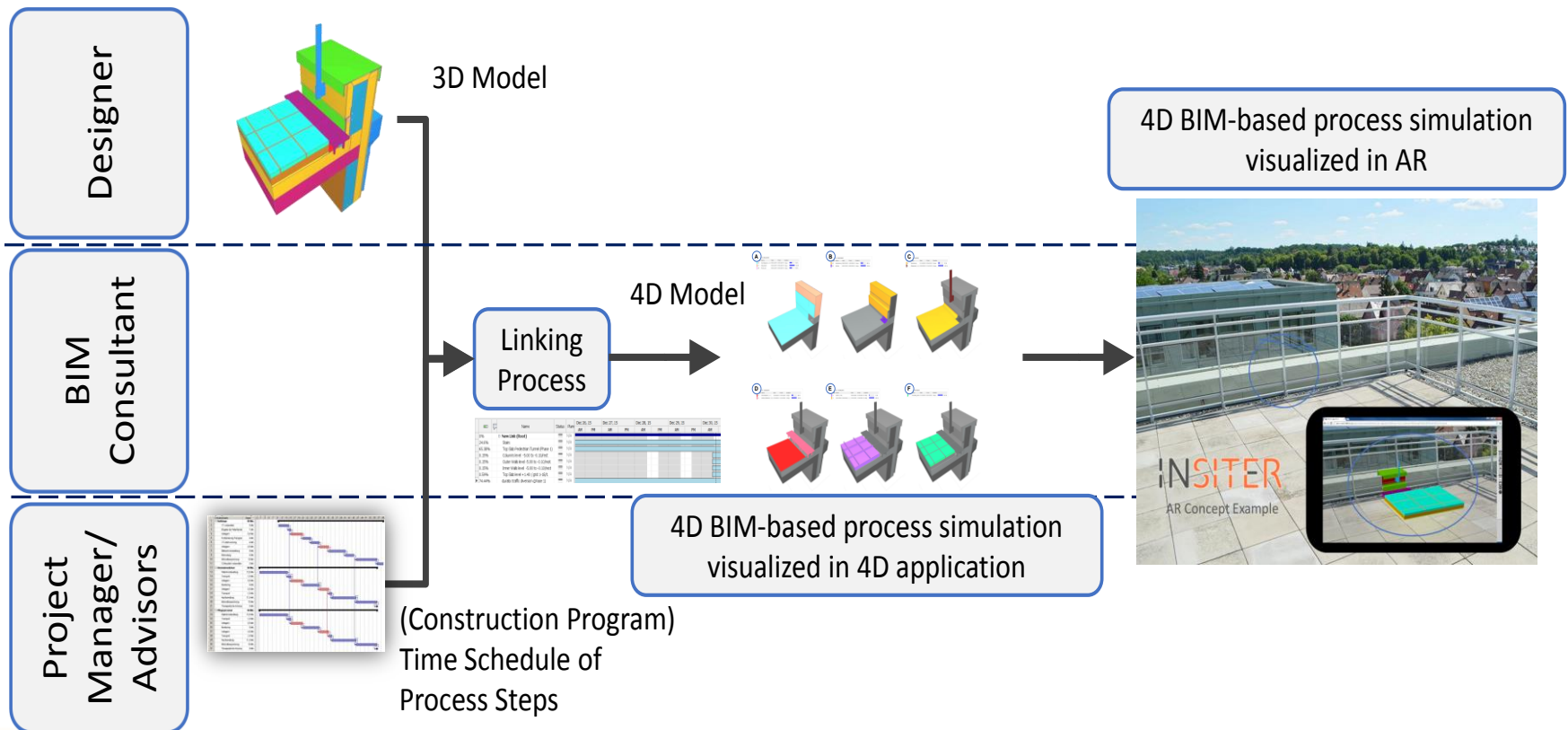
Augmented Reality as on-site guidance for the construction worker based on BIM



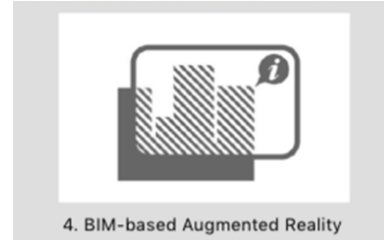


STEP 4 – BIM-BASED AR

Innovation: Combination of BIM and AR applying on-site for the construction worker



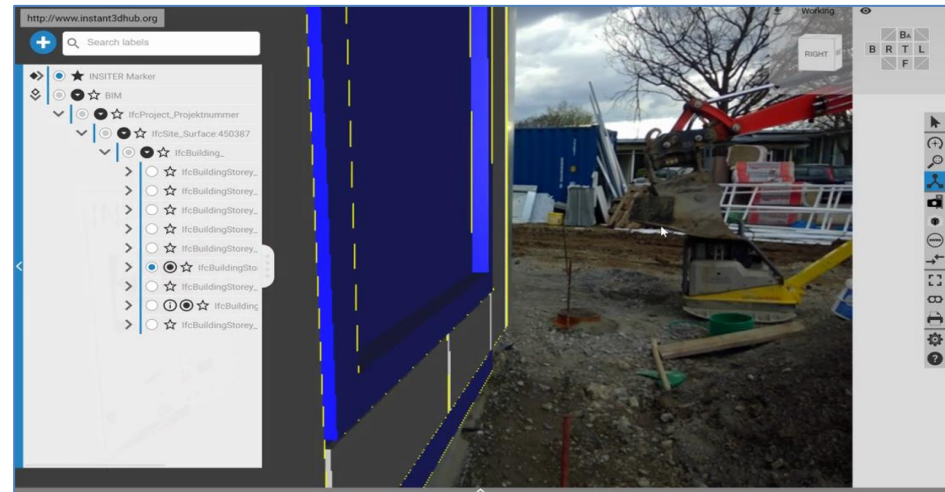
STEP 4 – BIM-BASED AR



Tools:

INSITER BIM AR Vision App

Visualization of building parts or equipment to be installed
BIM-based AR evaluation of defined BIM objects concerning the correct location and placement of the real construction objects



INSITER HoloLens BIM based reality App

Hands-free solution concerning detailed BIM model evaluation for self-inspection with focus on MEP and HVAC systems



STEP 4 – BIM-BASED AR

Target: Visual guidance for BIM elements (e.g. HVAC & MEP - installation location). Comparison between BIM model and real on-site situation. Evaluation of construction objects according to design requirements.

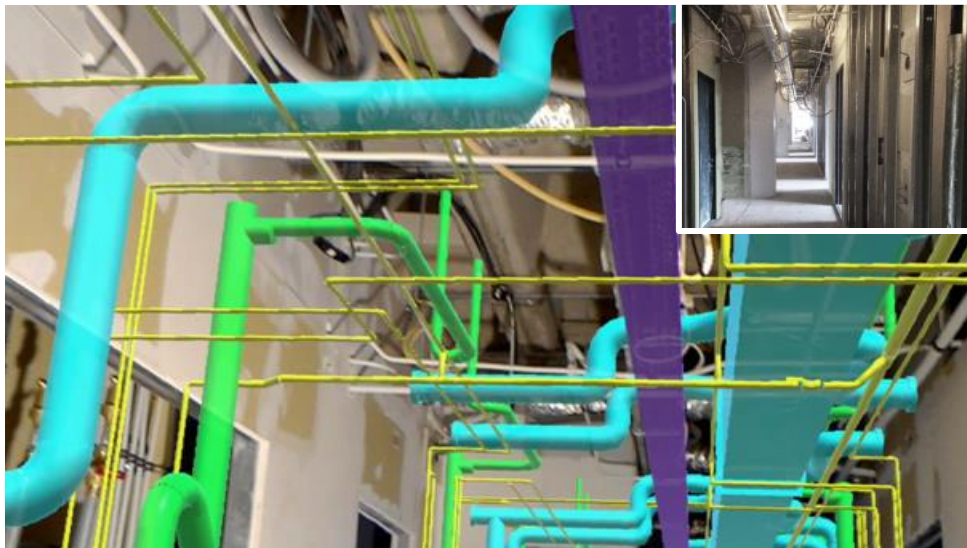
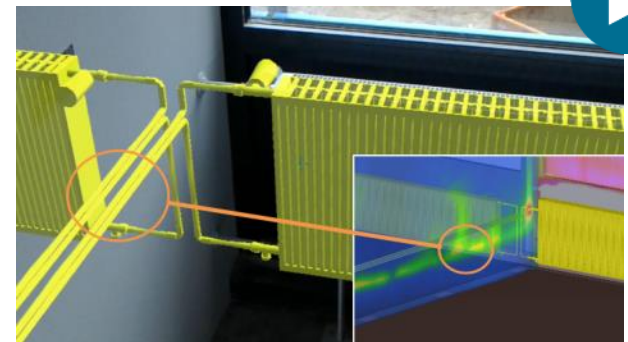
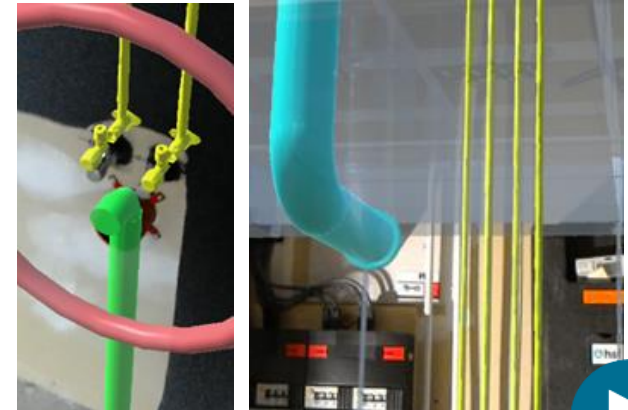


4. BIM-based Augmented Reality

The Story behind:

Using the mobile device (smartphone, tablet or HoloLens) equipped with an AR application, the construction worker projects the BIM model of the new BIM components to be installed onto the real spatial environment.

Screenshots:



STEP 4 – BIM-BASED AR



4. BIM-based Augmented Reality

Video Fraunhofer



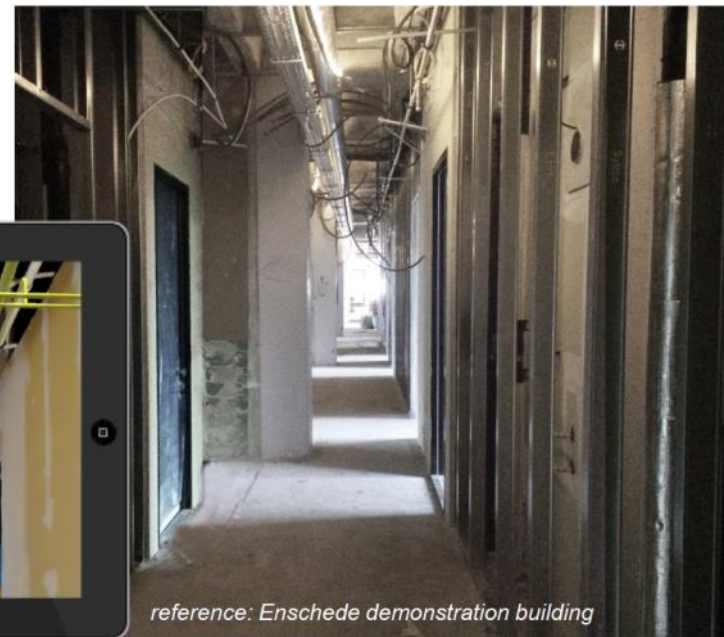
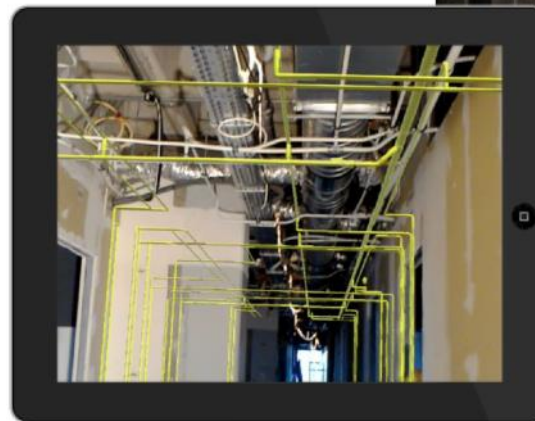
INSITER GUIDELINES



4. BIM-based Augmented Reality

- **INSITER guidelines timeline for the construction worker**

Step 4-5: BIM-based AR and Clash detection Using the mobile device equipped with an AR application, the construction worker projects the BIM model of the new HVAC components to be installed onto the real spatial environment. The worker on site can project the designed situation (correct situation) of the critical EeB components on real situation within the building, while focusing on the criticalities (clashes).



reference: Enschede demonstration building

BIM-BASED AUGMENTED REALITY

Robust and practical solutions of Augmented Reality for construction sites

INSITER Solutions

INSITER BIM AR Vision:

Complex BIM Models, Planning and Instrumentation Data

Visualized Planning Data

AR Solution for extensive and complex IFC BIM models for on-site self-inspection with referenced planning, self-instruction documentation and instrumentation data (with tablet computers)

INSITER HoloLens BIM-based Mixed Reality:

Detailed BIM-based 3D scenes, including e.g. MEP systems etc.

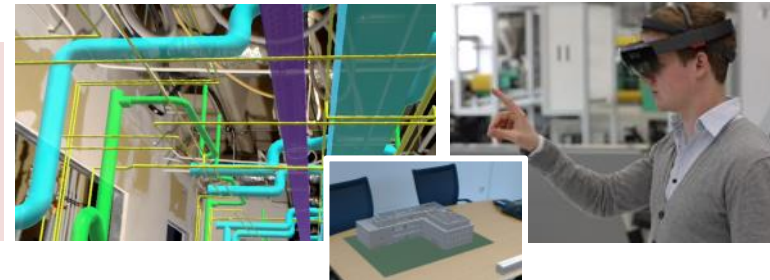
Detailed 3D scenes and BIM model evaluation for on-site self-inspection or self-instruction (with MS HoloLens)

INSITER BIM-based Self-Instruction AR:

Detailed BIM-based Process Guidance and Simulation

Detailed self-instruction simulation and visualization (with tablet computers, smart glasses or MS HoloLens)

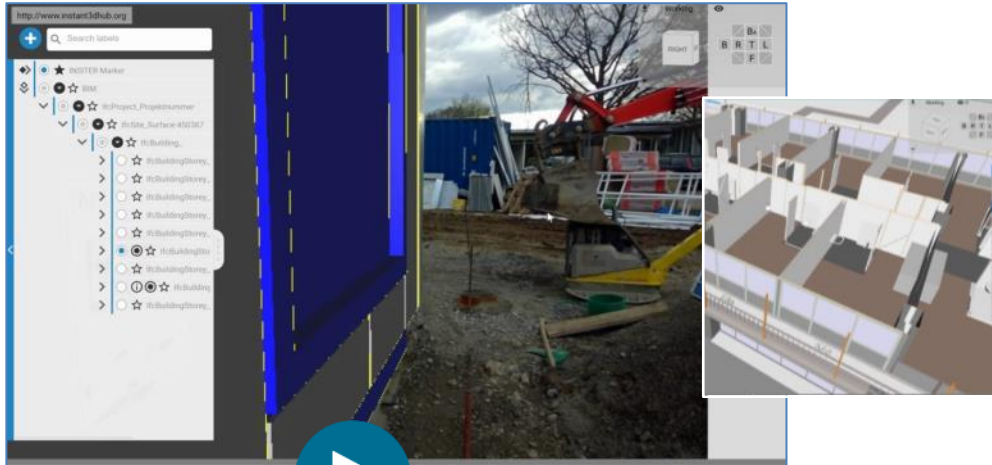
Screenshots



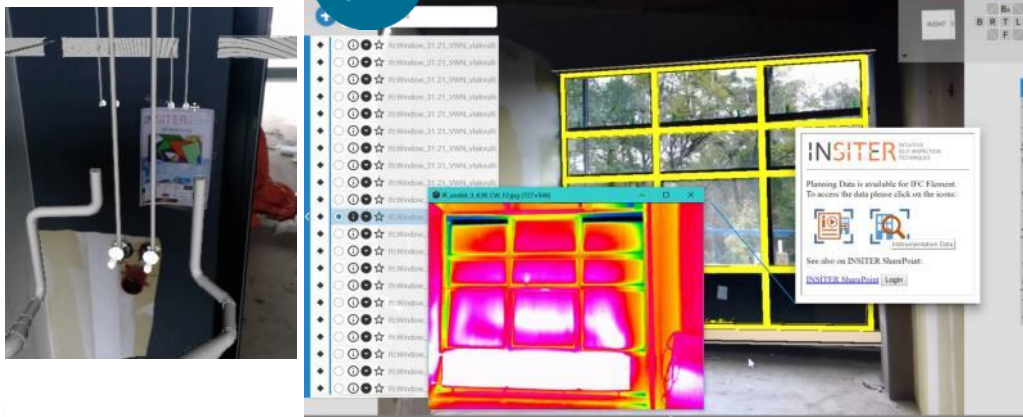
INSITER BIM AR VISION

Robust and practical solutions of Augmented Reality for construction sites

AR Solution for extensive and complex IFC BIM models for on-site self-inspection with referenced planning, self-instruction documentation and instrumentation data. Hardware: tablet computers

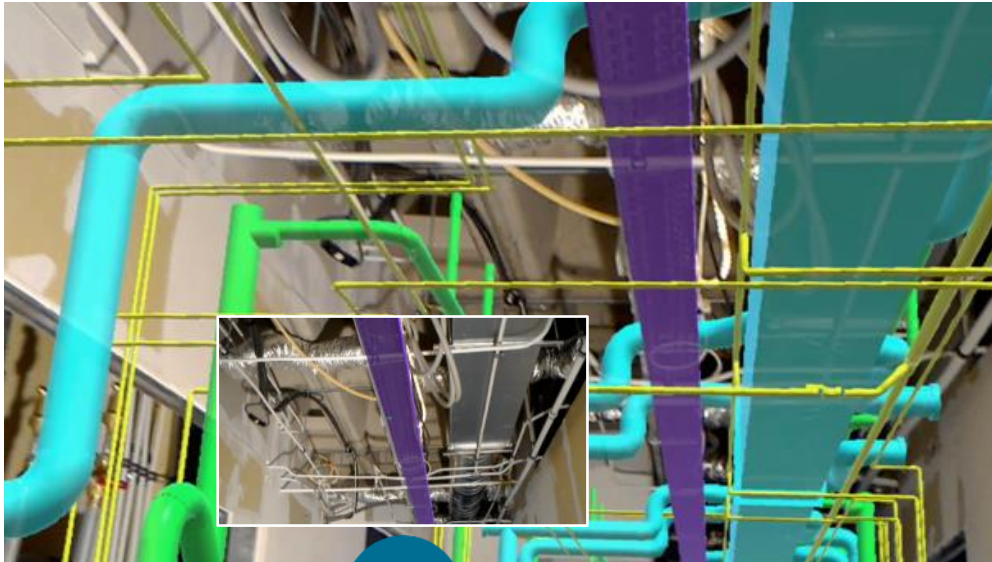


- Visualization complex BIM in AR
- In-situ visualization of building elements, parts or equipment to be installed or verified
- Access of referenced planning information on INSITER SharePoint (guidelines, instrumentation data, etc.)
- Evaluation BIM objects and prefabricated façade panels concerning e.g. the correct location and construction position
- Identification of construction inconsistencies and errors



INSITER HOLOLENS BIM-BASED MIXED REALITY

Head mounted AR see through solution in combination with spatial mapping based object tracking
→ Enhanced hands-free self-inspection and self-instruction capabilities for detailed BIM scenes.
Hardware: MS HoloLens



- Hands-free self-instruction and inspection with visualization and validation of BIM elements or technical building services (MEP/HVAC)
- Visual guidance and evaluation, where BIM components or e.g. MEP elements should be installed, including a comparison between virtual BIM model and real on-site situation
- Identification of construction inconsistencies in Mixed Reality
- Speech recognition

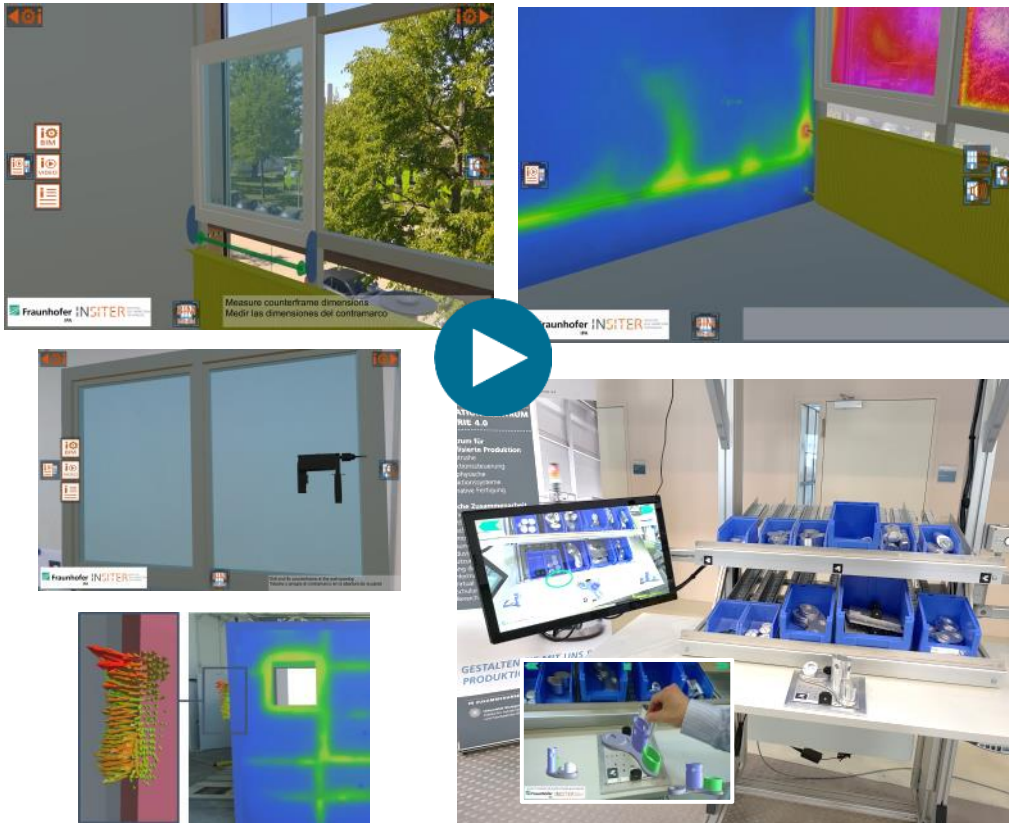


INSITER HOLOLENS BIM-BASED MIXED REALITY

Detailed self-instruction simulation and visualization

Hardware: tablet computers or also smart glasses such as MS HoloLens

Robust and practical solutions of Augmented Reality for construction sites



- BIM-based Self-Instruction visualization of building elements or variant to be assembled
- In-situ visualization of work instructions in combination with the real object or workpiece.
- Localization of process associated parts to be installed incl. material supply boxes (if available, optional)
- Documentation and further instructions such as documents or videos
- Instrumentation and sensor data such as thermal images or acoustic measurement visualized for self-inspection

INSITER BIM-BASED MIXED REALITY - BENEFITS

- Enhanced capabilities of any actor or stakeholder on site for self-inspection and self-instruction activities
- Errors can be prevented, quality can be improved and the overall work performance can be optimized
- Prototype applications can be deployed on mobile devices or wearable smart glasses
- Challenges national and international regulations which do not yet cover the usage on construction sites or within factories.



4. BIM-based Augmented Reality

INSITER BIM-BASED MIXED REALITY - BENEFITS

- Interactive on-site worker support
 - Error-free assembly of BIM components with visual guidance and evaluation
 - Component mix-up can be prevented
 - Targeted and guided project control, work processes e.g. for installation, assembly and maintenance

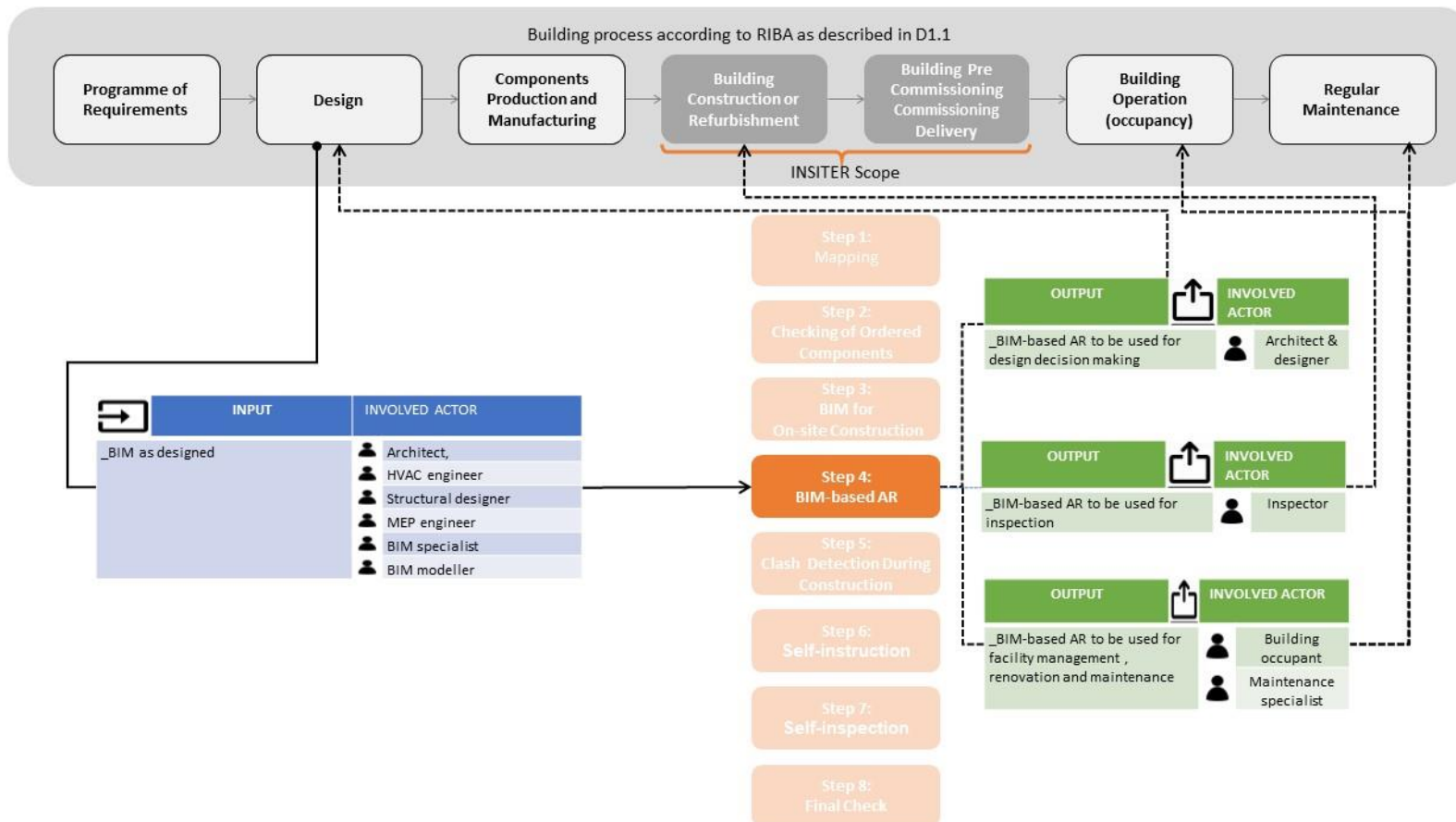


4. BIM-based Augmented Reality



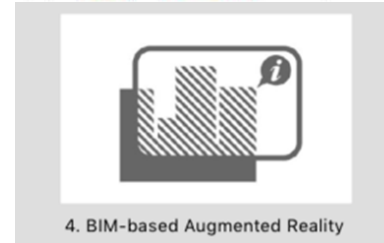
4. BIM-based Augmented Reality

STEP 4 – BIM-BASED AR – ACTORS



STEP 4 – BIM-BASED AR- QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS

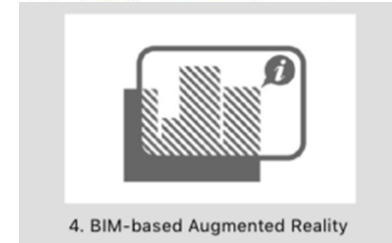


INSITER step	INSITER description	Task name		SUB-task name(s)
4	Generating and deploying BIM-based Augmented Reality (AR) for self-instruction and self-inspection	Generate and deploy BIM-based Augmented Reality (AR) for self-instruction and self-inspection	Stock the wished instructions and inspections in coördination with the construction worker; instruct the software developer	4.1
4	Generating and deploying BIM-based Augmented Reality (AR) for self-instruction and self-inspection	Generate and deploy BIM-based Augmented Reality (AR) for self-instruction and self-inspection	Embed BIM and VR in Augmented Reality Extract BIM/ VR process information into self-instructions for construction workers on their smart devices Generate self-inspection modules for construction workers on their smart devices	4.2



STEP 4 – BIM-BASED AR- QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS



Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
4.1 Building engineer/ building site manager	Which instructions and inspections in AR are needed and possible for the construction worker	Which instructions and inspections in AR are workable for the construction worker	Stock the wished instructions and inspections in coördination with the construction worker; instruct the software developer
4.2 Software developer	Structure of the BIM-model; how to change the BIM-model suitable for the AR device; incorporating BIM into the inspection software	How the construction worker can use the AR-device for self-instruction and self-inspection	Embed BIM and VR in Augmented Reality Extract BIM/ VR process information into self-instructions for construction workers on their smart devices Generate self-inspection modules for construction workers on their smart devices



NEW GUIDELINE STEP 4 – BIM-BASED AUGMENTED REALITY

New critical EeB component: ...

...

Step 1:
Mapping

Step 2:
Checking of Ordered
Components

Step 3:
BIM for On-site
Construction

Step 4:
BIM-based AR

Step 5:
Clash Detection
during Construction

Step 6:
Self-instruction

Step 7:
Self-inspection

Step 8:
Final Check

INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

E.g.:

- Accurately following the building design
- Understanding the task and expected result
- ...

Key activities

E.g.:

- Visualization of the BIM and 3D objects in the on-site environment using Augmented Reality
- Visually check the correct location and construction position
- Add task descriptions
- ...

Special attention

E.g.:

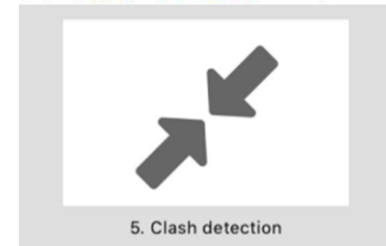
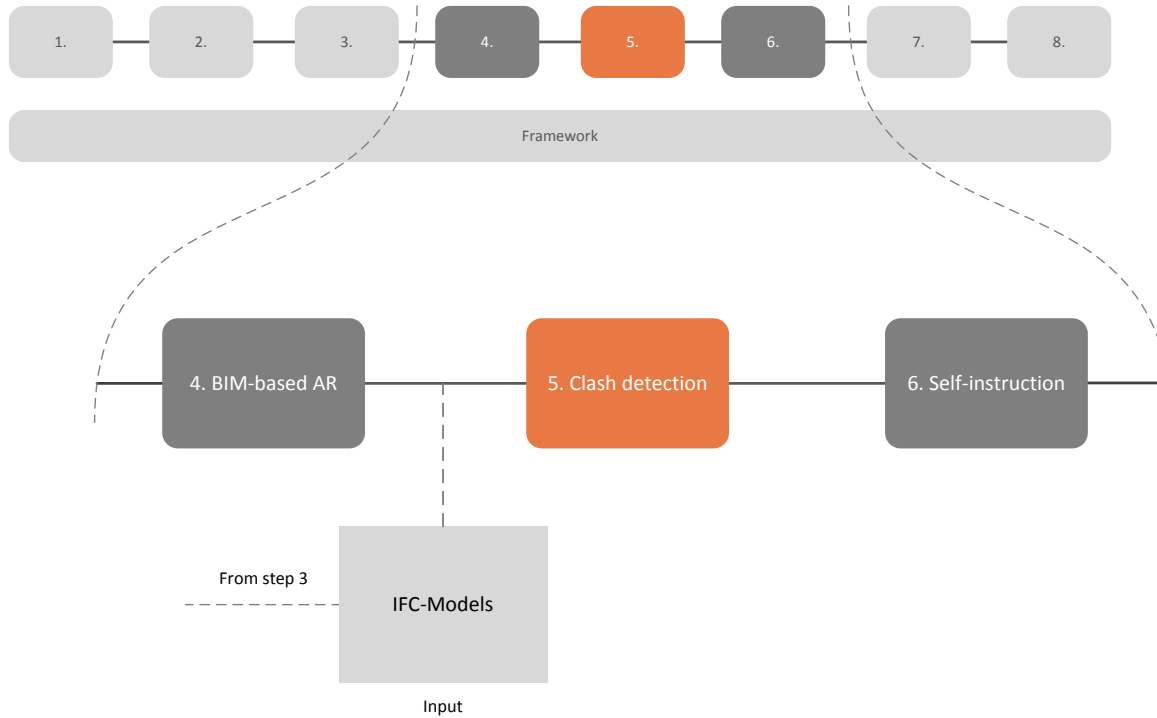
- Note if any detail of the component is missing in BIM
- ...

Technical information

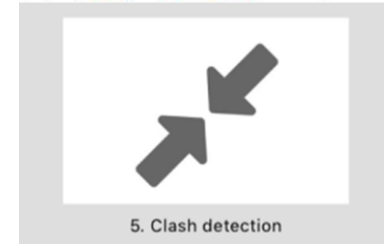
E.g.:

- Task descriptions to be displayed in AR
- ...

STEP 5 – CLASH DETECTION



STEP 5 – CLASH DETECTION



Determining the implications that on-site deviations have on the construction process

The screenshot displays the Autodesk Navisworks Manage 2016 interface. The 'Clash Detect' window is open, showing a table of detected clashes. The table has columns for Name, Status, Clashes, New, Active, Reviewed, Approved, and Resolved. The selected clash is '001-001-ACEI-HVAC' with a status of 'New' and a date of '11:52:03 07-11-2017'. Below the table, the 'Items' section shows the specific elements involved in the clash: 'Hoopkamp_ARC_BG_20171106_ifc4.ifc' and '00 beqane grond_SeparatedModel_Number_3.ifc'. The 3D model on the right shows a red wavy line indicating a clash between a suspended ceiling and a duct system.

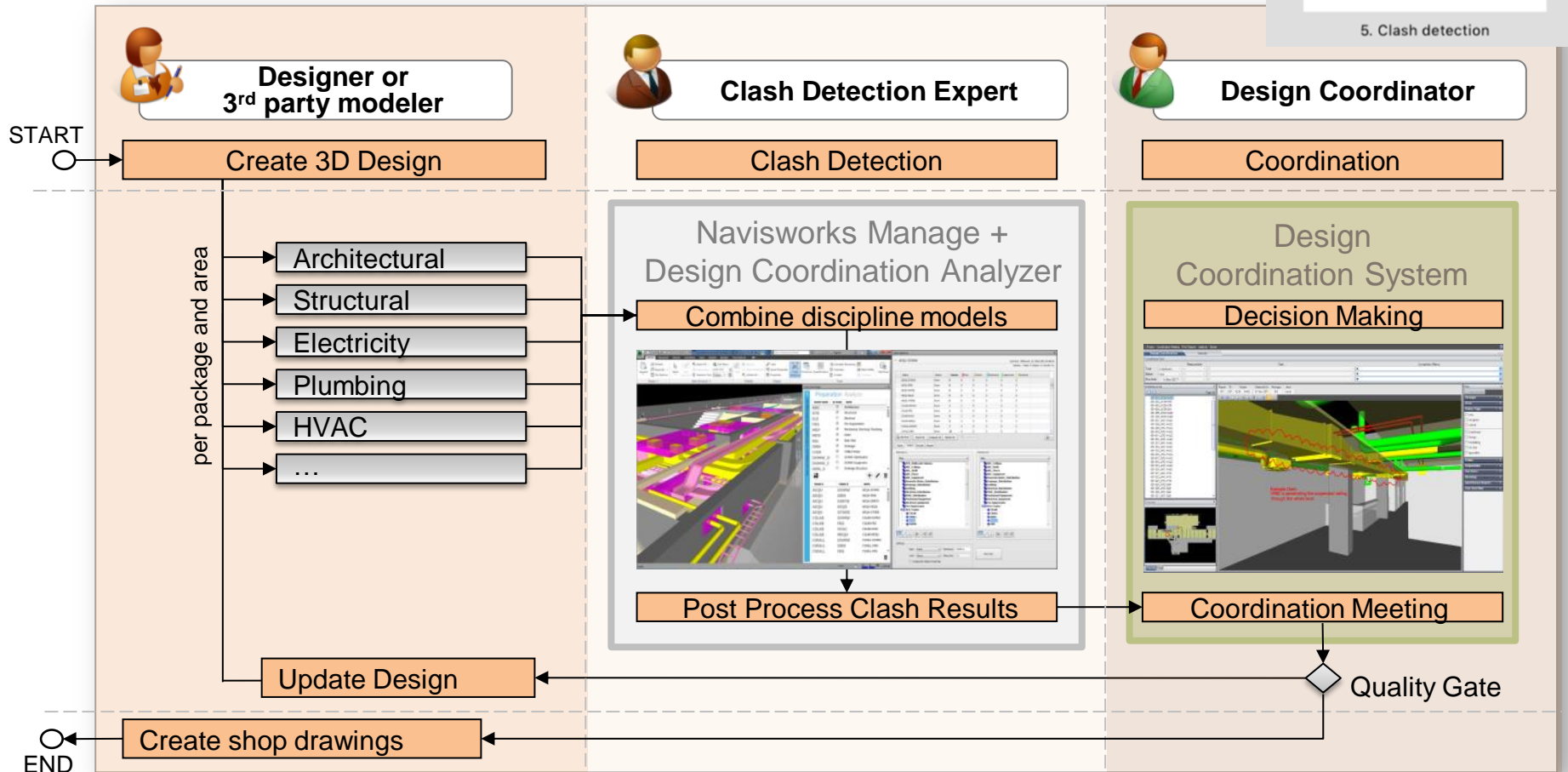
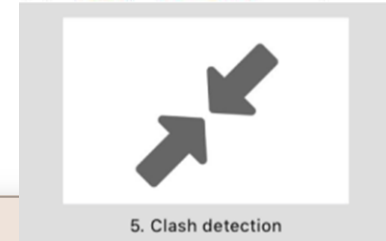
Name	Status	Clashes	New	Active	Reviewed	Approved	Resolved
ACEI-DVCE	Done	0	0	0	0	0	0
ACEI-HVAC	Done	2	1	0	1	0	0
ACEI-HVD	Done	4	2	0	2	0	0
ACEI-MISC	Done	1	0	0	1	0	0
ACEI-SAN	Done	2	1	0	1	0	0

Clash Detect - Saved Viewports | Selection Tree

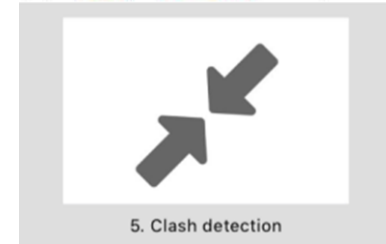
Ready

Example Clash:
/AC is penetrating the suspended ceiling rough the whole level.

3D DESIGN COORDINATION HIGH LEVEL PROCESS: INTRODUCTION TO CLASH DETECTION



STEP 5 – CLASH DETECTION



Off-site process performed by BIM manager to optimize the design and avoid errors detection:

- **Navisworks manage-clash detective**

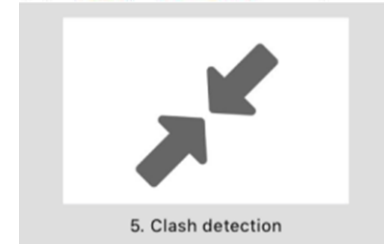
Additional software tools for on-site clash detection:

- **Design Coordination Analyzer**
 - Clash reports for further coordination tasks
- **Clash Cube Creator**
 - Collects information from clashes and transforms it into small cubes to use on-site
 - Connection between off-site clash detections and the on-site team



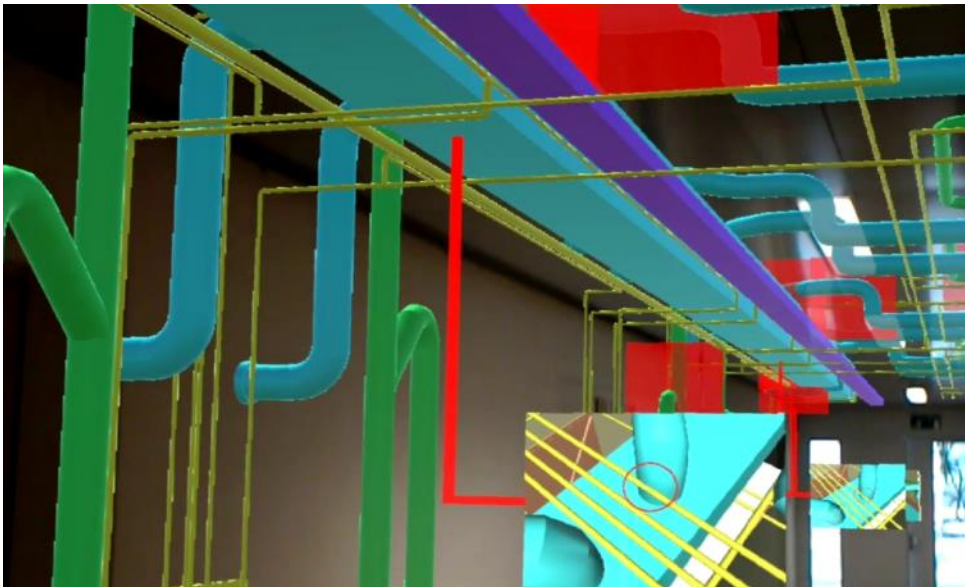
STEP 5 – CLASH DETECTION ON-SITE

Target: Verification of the current site situation. Evaluation of clash cubes and clash analyses with clash images

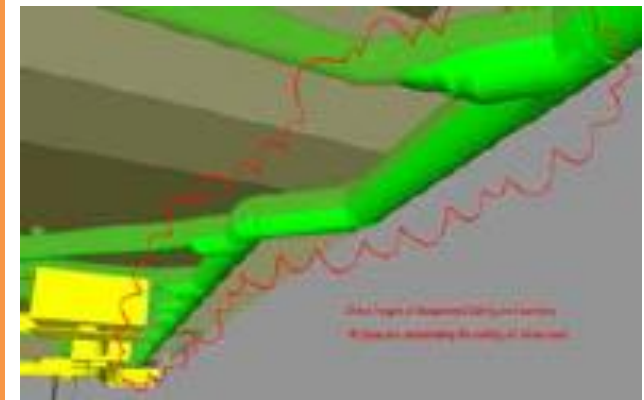


The Story behind:

Through AR, the construction worker visually observes whether the HVAC components to be installed really fit within the intended building part/space/room, i.e. no "clashes" with structural building components, etc.



Screenshots:

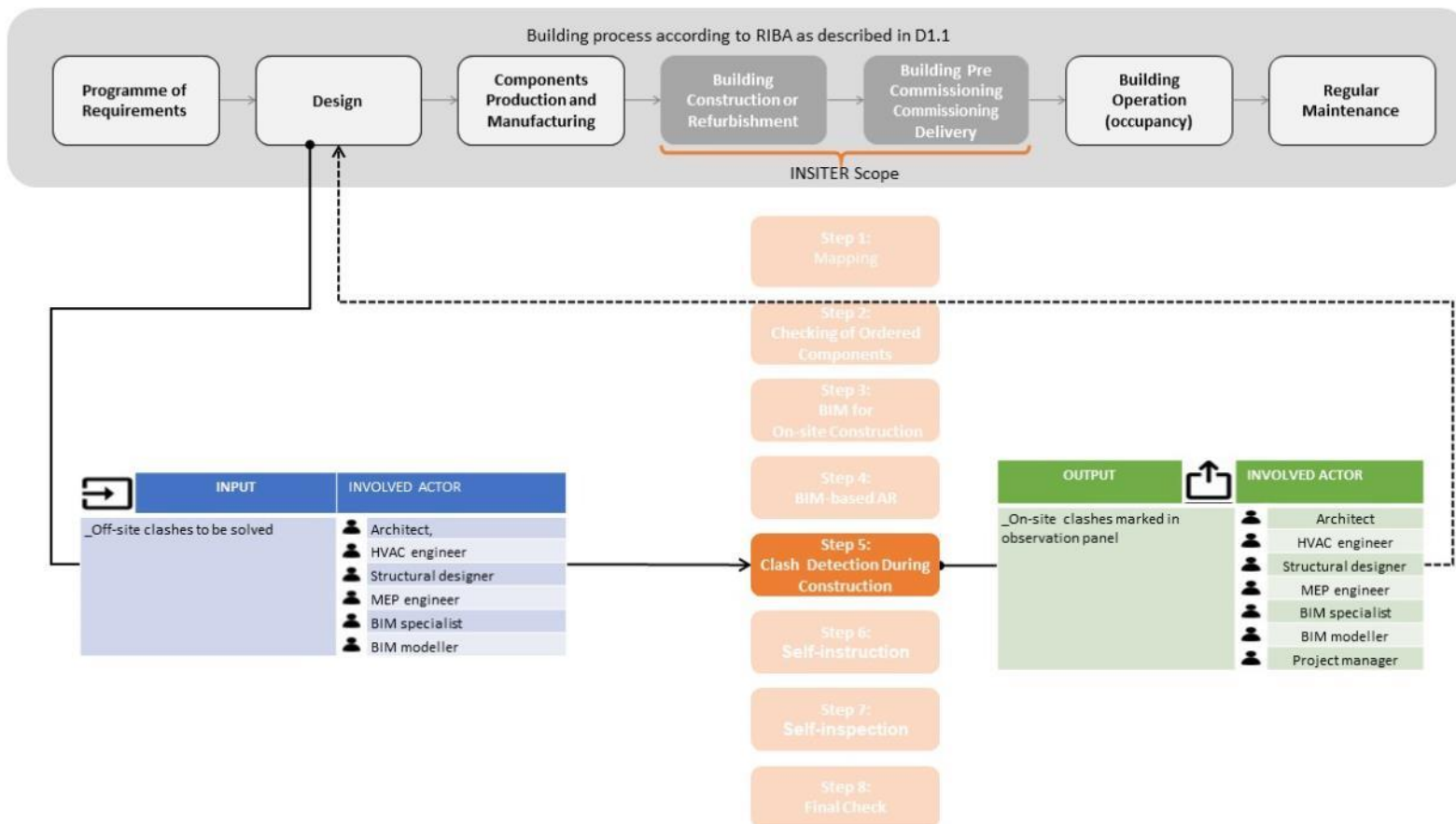
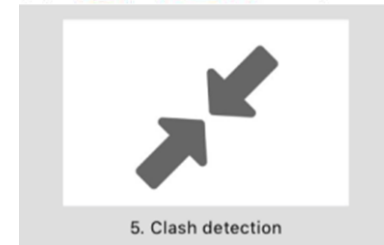


Interference Status		Interference Type		Interferences per Stakeholder	
Total: 49	Assigned: 37	Design: 28	Approved: 0	ARC: 18	HWAC: 25
None: 2	Spilled: 9	Modeling: 1	On Site: 3	HW3: 17	MCO: 10
		Undefined: 1			

Created Stakeholder	Assigned Stakeholder	Responsibility	Task	Completion Memo	Due Date
ARC	QCO	ARC	Check height of suspended ceiling		30.11.2017
HWAC	HW3	HWAC	Check height of HVAC ducts		30.11.2017
MCO	QNB	MCO	Check model according to design base		30.11.2017
ARC	STB	ARC			

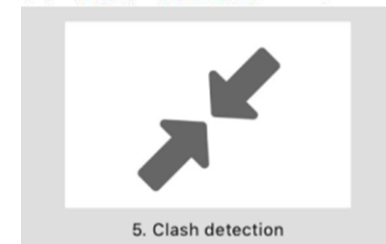
Interference ID	Trade 1	Trade 2	FACE	AREA	ARC	HWAC	HW3	MCO	STB	Total
01-001-ARC-HVAC	ARC	HWAC		1	2	1				4
01-002-ARC-HVAC	ARC	HWAC		1	1	1				3
01-003-ARC-HVAC	ARC	HWAC		1	1	1				3
01-004-ARC-HVAC	ARC	HWAC		1	1	1				3
01-005-ARC-HVAC	ARC	HWAC		1	1	1				3
01-006-ARC-HVAC	ARC	HWAC		1	1	1				3
01-007-ARC-HVAC	ARC	HWAC		1	1	1				3
01-008-ARC-HVAC	ARC	HWAC		1	1	1				3

STEP 5 – CLASH DETECTION – ACTORS



STEP 5 CLASH DETECTION – QUALIFICATIONS

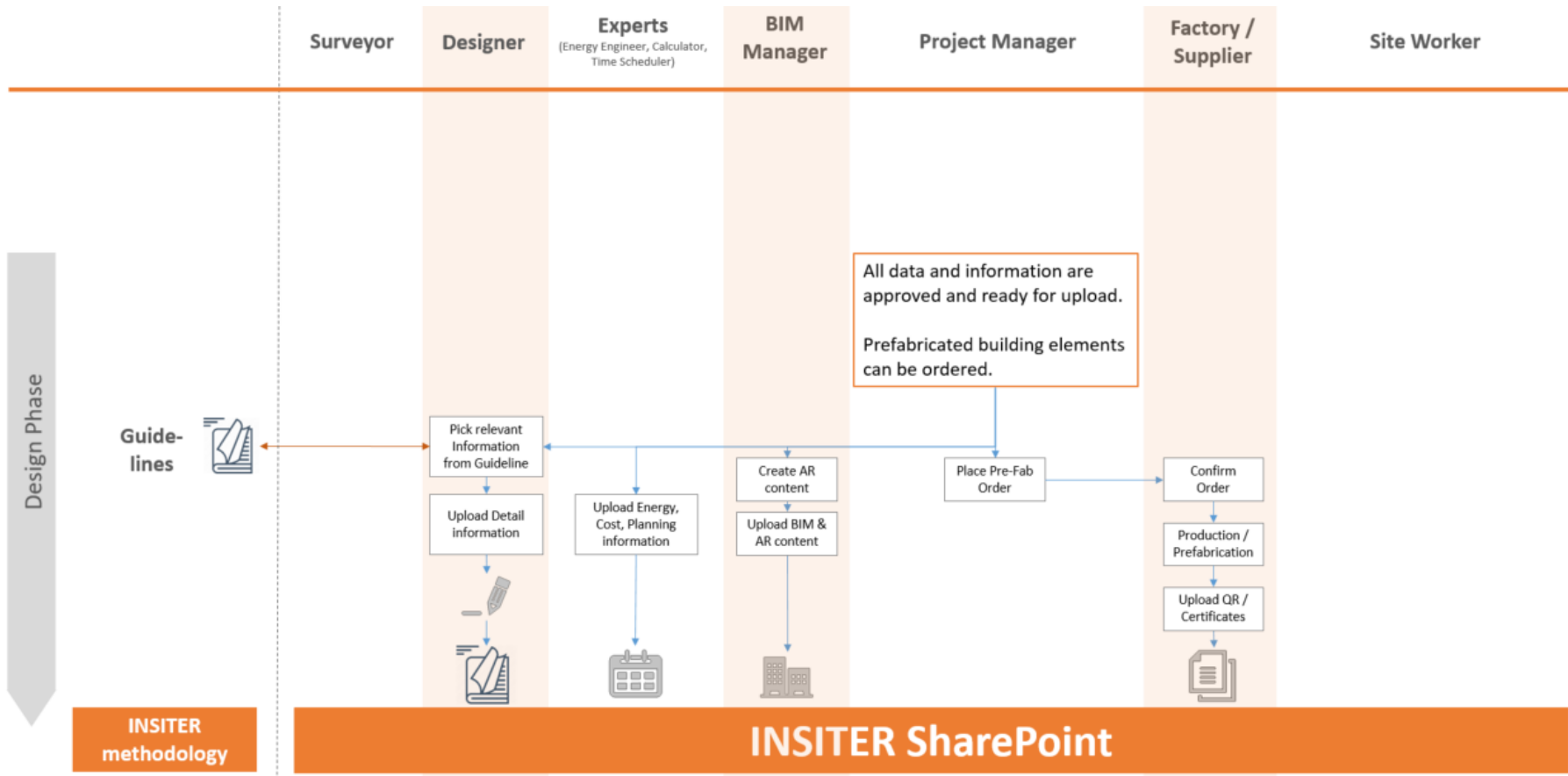
EXAMPLE PREFABRICATED FAÇADE PANELS



INSITER step	INSITER description	Task name		SUB-task name(s)
5	Virtual validation of quality and performance by BIM Model Checking and Clash Detection; as well as value and process optimisation by Virtual Reality simulation	Validate quality and performance by BIM Model Checking and Clash Detection	Understand the clashes and what to do if help materials of the façade are not in place or not correctly assembled	5.1
		Optimize value and process with Virtual Reality simulation	Understand the detected clashes and deliver instructions for the construction worker	5.2

Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
Construction worker	How to read the BIM-model; how to use the AR device	The position of the prefabricated panel in the BIM-model; Which materials of the façade have to be in place (visible in VR and BIM) before the prefabricated panel can be assembled; Are the helpmaterials of the façade placed correctly to assemble the prefabricated panels	Understand the clashes and what to do if help materials of the façade are not in place or not correctly assembled
Building site manager			Understand the detected clashes and deliver instructions for the construction worker

PROVIDING INPUT & PLACEMENT OF PREFAB-ORDER



NEW GUIDELINE STEP 5 – VISUAL CLASH DETECTION DURING CONSTRUCTION

New critical EeB component: ...

...

Step 1:
Mapping

Step 2:
Checking of Ordered
Components

Step 3:
BIM for On-site
Construction

Step 4:
BIM-based AR

Step 5:
Clash Detection
during Construction

Step 6:
Self-instruction

Step 7:
Self-inspection

Step 8:
Final Check

INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

E.g.:

- Inconsistencies because of elements that require more space than drawn
- Inconsistencies because of elements with breached bufferzones

Key activities

E.g.:

- Test and check through AR if the component can be placed at the intended spot

Special attention

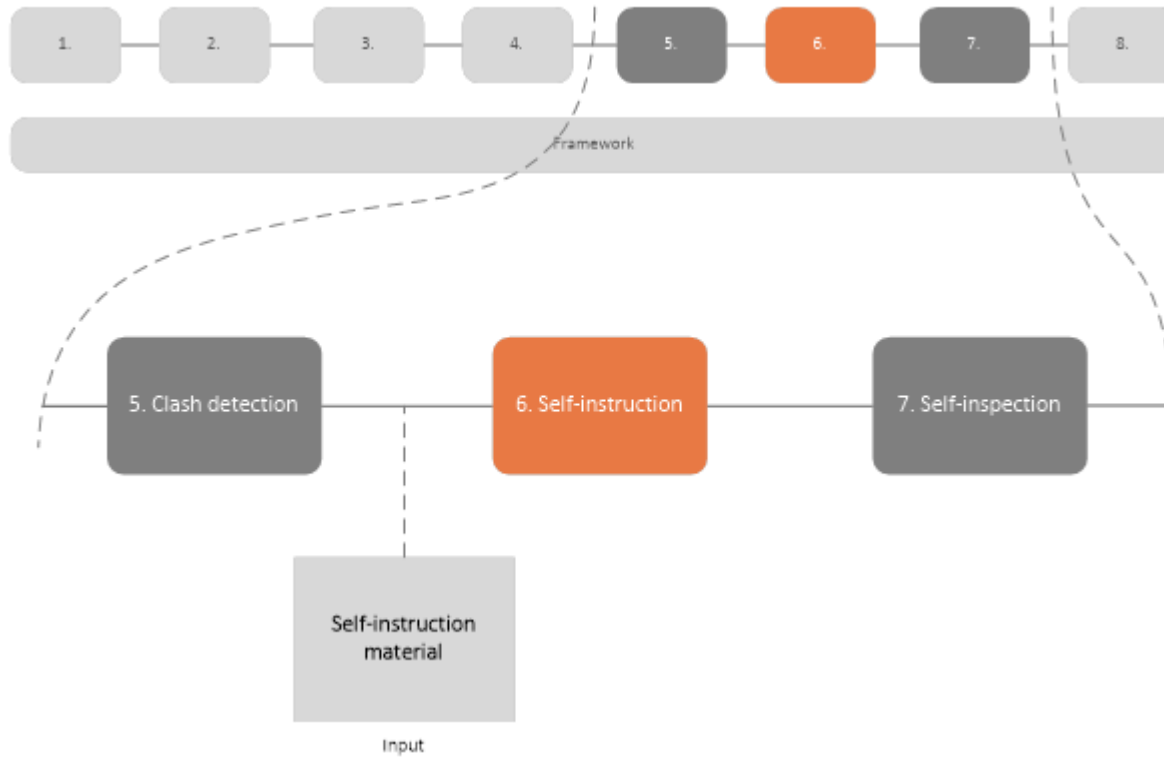
E.g.:

- Checks for wrong slope or misalignments of the piping
- Checks for incorrect flashing

Technical information

No extra data required.

STEP 6 – SELF- INSTRUCTION



STEP 6 – SELF- INSTRUCTION

Providing user-friendly self-instruction material to the construction worker



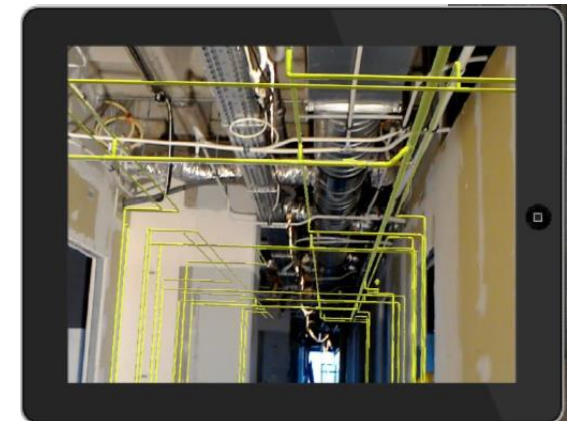
STEP 6 – SELF- INSTRUCTION



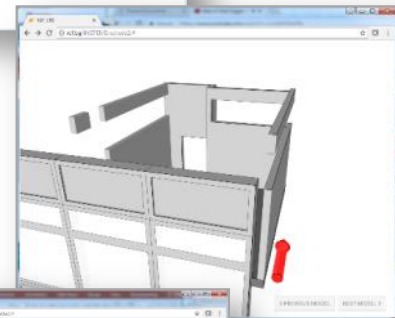
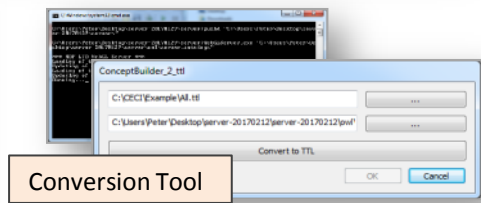
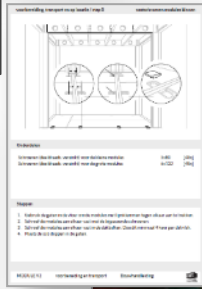
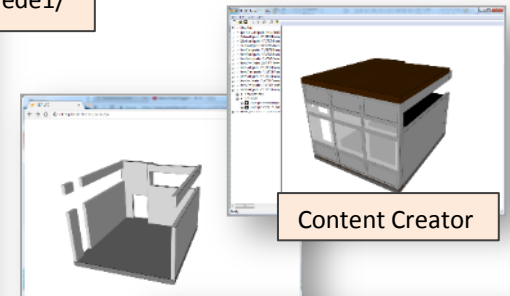
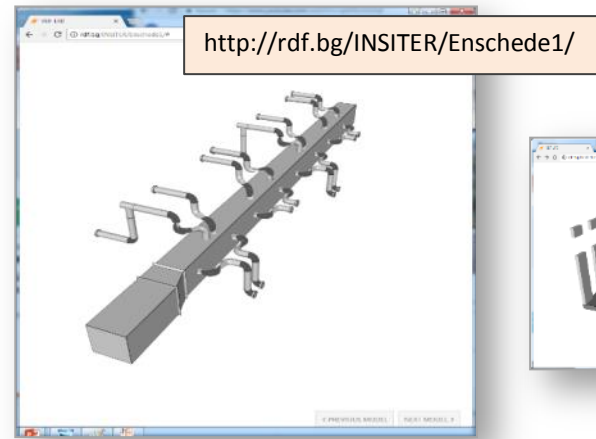
INSITER added value:

Self-instruction for the construction worker

- ✓ Instructions for on-site use in RE Construct
- ✓ Identifying the related construction part of a building (QR code, 3D-viewer)
- ✓ Accessing documents, photos and videos for the selected construction part (developed Guidelines)
- ✓ AR technology
- ✓ Step-by-step instruction creation



BIM-BASED SELF-INSTRUCTION MODELS FOR MOBILE DEVICES



http://www.mainheating.co.uk/docs/main_combi_30_he_installation_service.pdf



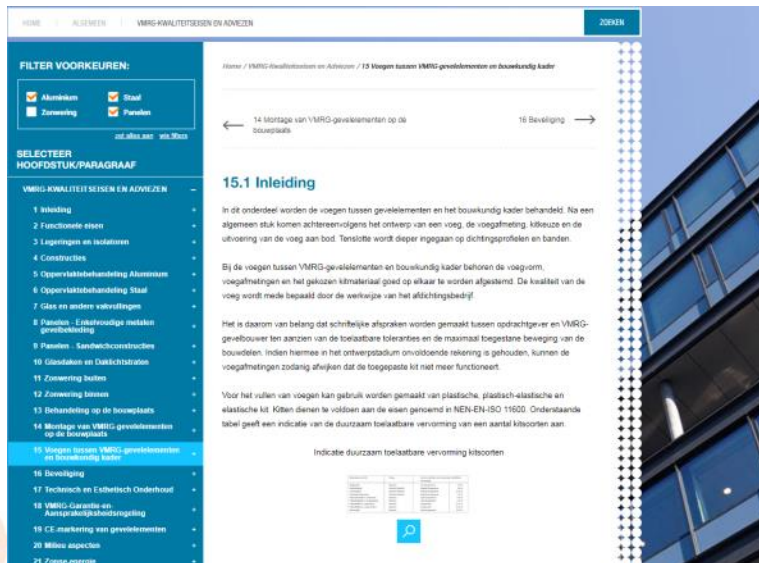
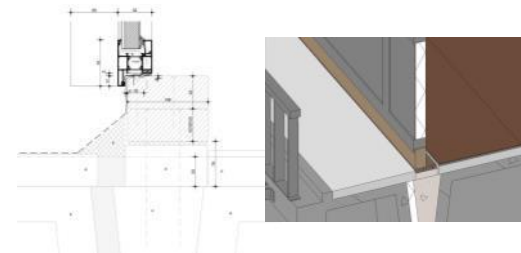
STEP 6 – SELF-INSTRUCTIONS

Target: Guiding the construction process using a mobile device

The Story behind:

The construction worker opens the manual documents / videos / animations where the mounting of the façade elements or MEP-components is described in step-by-step process steps with easy guidance and hints/warnings of common errors to be avoided.

Screenshots:



INSITER GUIDELINES



- INSITER guidelines timeline for the construction worker

Step 6: Self-instruction

The construction worker opens the manual documents/videos/animations where the mounting of the critical EeB components is described in a step-by-step process.



reference: Delft demonstration building

PROJECT HOGEKAMP, ENSCHEDE



STEP 6 – SELF-INSTRUCTIONS

Target: Guiding the construction process with a focus on airtightness



The Story behind:

The instruction of the workers was done in 2 steps:

1. Toolbox meeting for airtightness
2. Self-instruction by Ikea-like manual

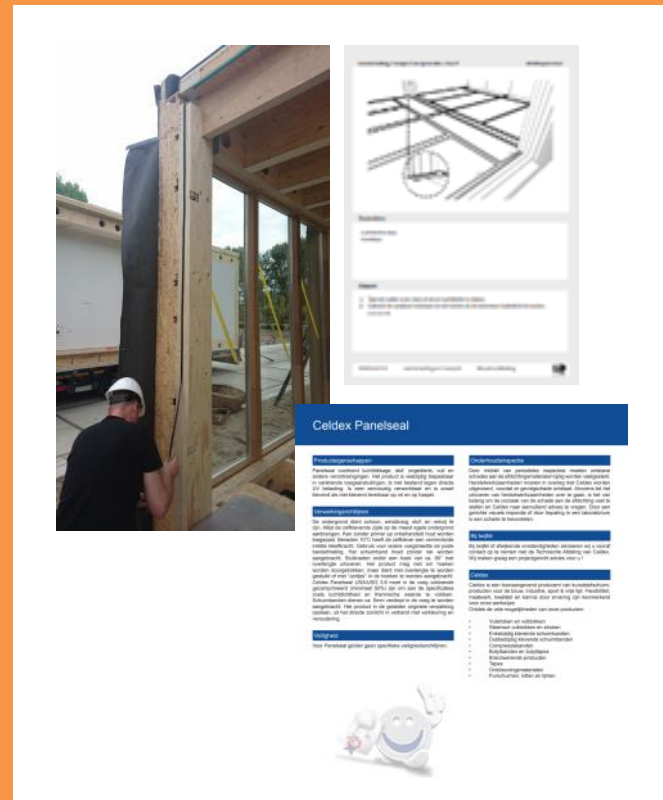
What can be changed via INSITER:

The toolbox meeting can be replaced by a video with the specific project based information.

The Ikea-like self-instruction can easily be incorporated in the BIM-model.

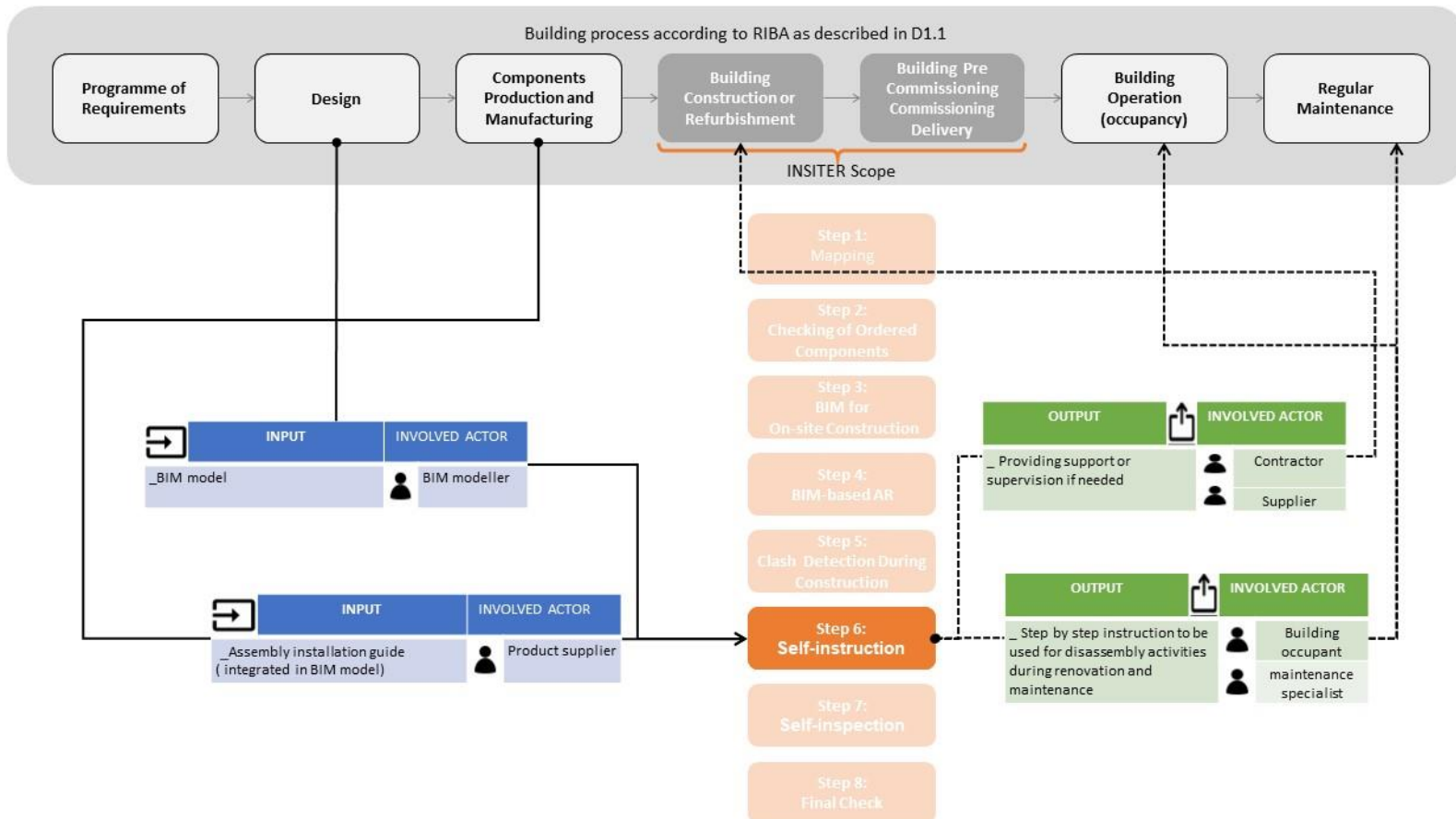
The manual how to apply the sealant can be added to the BIM-system

Screenshots:





STEP 6 – SELF- INSTRUCTION – ACTORS



STEP 6 SELF-INSTRUCTION QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS

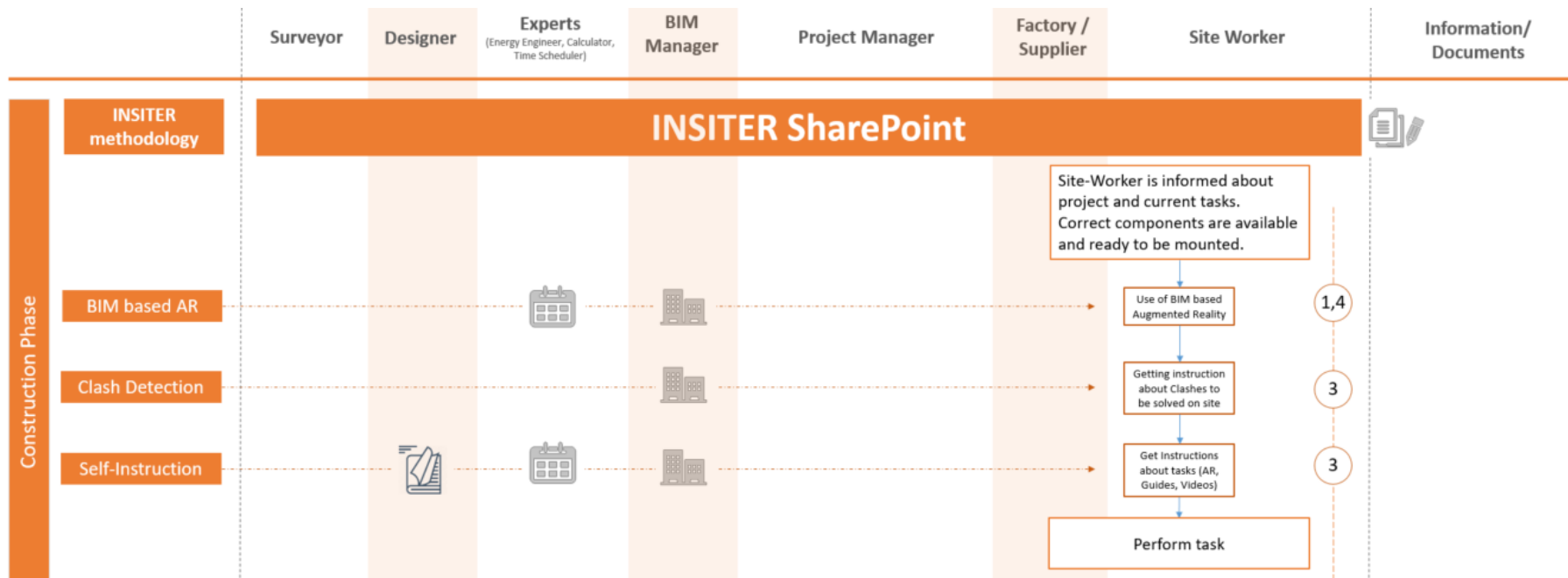


INSITER step	INSITER description	Task name		SUB-task name(s)
6	Self-instruction during preparation and execution of construction site and logistics.	Follow self-instruction during preparation and execution of construction site and logistics.	Assemble the prefabricated panels with the instructions from a smart device	6.1

Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
Construction worker	The dimensions and the position of the prefabricated panel in the BIM-model and how to work with the AR device; which materials are used to assemble the prefabricated panel in the façade	How to assemble the prefabricated panels in the façade, according to the instructions from a smart device	Assemble the prefabricated panels with the instructions from a smart device



SELF-INSTRUCTION OF THE SITE-WORKER



- INSITER prevents:**
- 1: Errors due to lack of time for construction
 - 2: Errors due to wrong delivered / damaged components
 - 3: Errors due to bad preparation / insufficient information
 - 4: Errors due to different site situation
 - 5: Errors due to bad performance
 - 6: Bad project management due to outdated information



NEW GUIDELINE STEP 6 – SELF-INSTRUCTION

New critical EeB component: ...

...

Step 1:
Mapping

Step 2:
Checking of Ordered
Components

Step 3:
BIM for On-site
Construction

Step 4:
BIM-based AR

Step 5:
Clash Detection
during Construction

Step 6:
Self-instruction

Step 7:
Self-inspection

Step 8:
Final Check

INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

E.g.:

- Installation or mounting according to the installation manual
- Correct positioning of the piping
- Using the correct sealings
- Using the correct auxiliary materials / fasteners
- ...

Key activities

E.g.:

- Check the critical details of the component
- Watch and/or read the relevant instructions
- Follow up special recommendations
- Use the included materials
- ...

Special attention

E.g.:

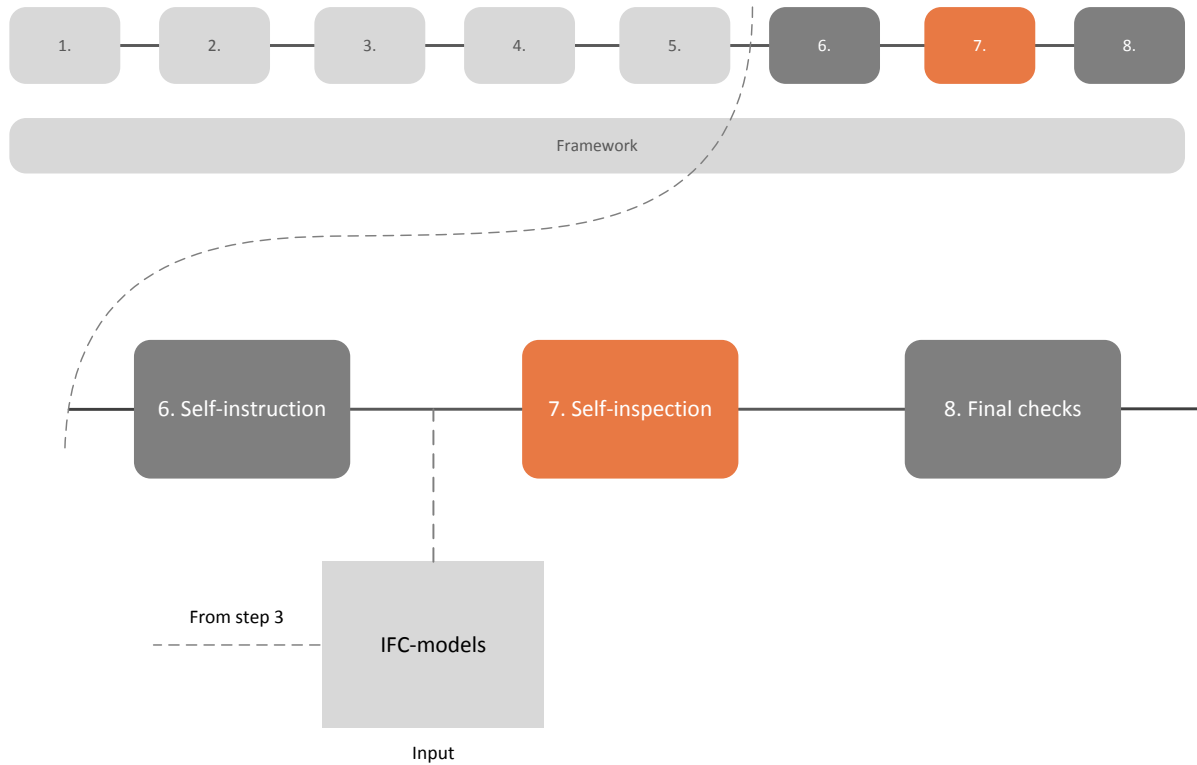
- Replace or reconnect anything that has been removed before mounting
- Repair the water resistant layer
- Repair damaged connections or elements
- ...

Technical information

E.g.:

- Assembly manual (PDF)
- Tutorial videos
- BIM based self-instruction model for mobile devices (IFC)
- Special or specific instructions
- ...

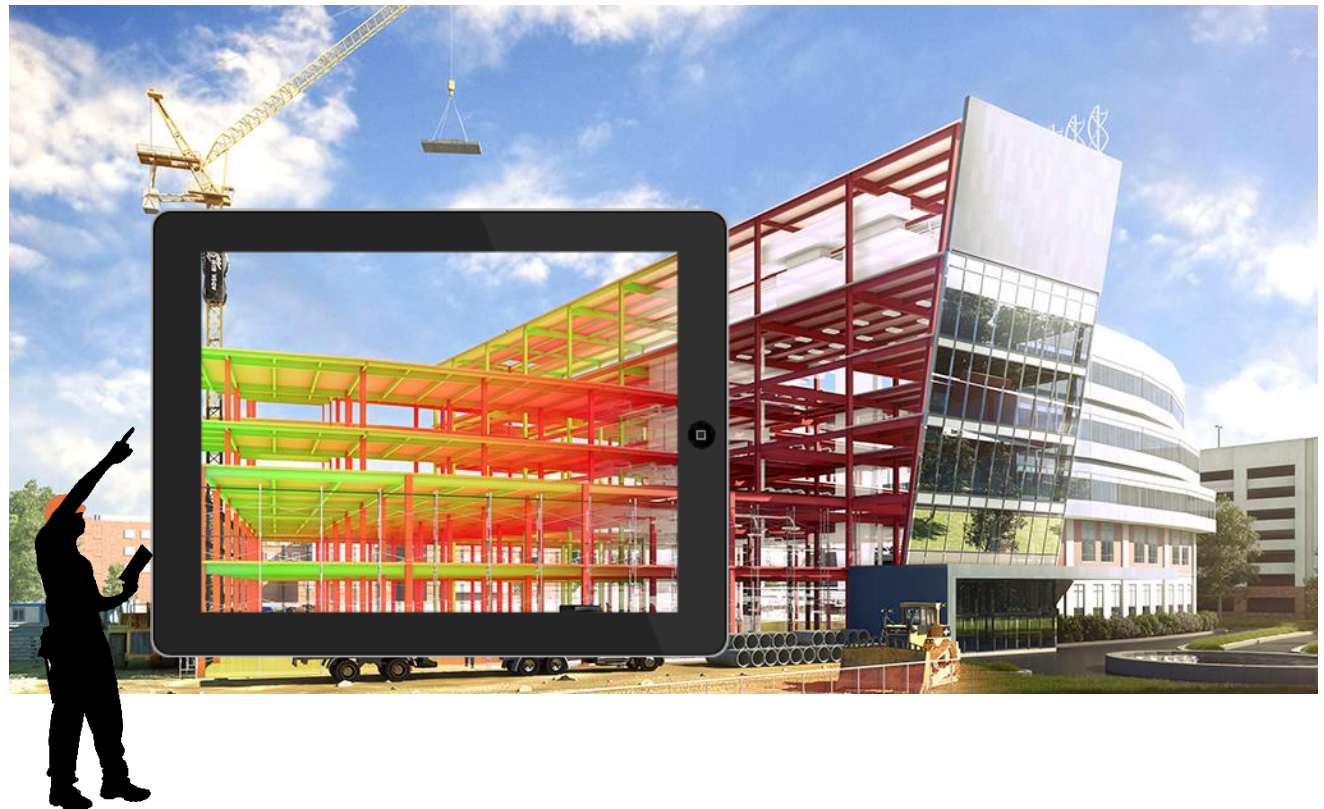
STEP 7 – SELF- INSPECTION



STEP 7 – SELF- INSPECTION



Inspecting one's own and each other's work on-site and identifying deviations



STEP 7 – SELF- INSPECTION

On INSITER iPad application, RE OnSite



Self-inspection of the construction worker by following the next steps:

- ✓ Prepare all the relevant checklists and information to conduct the self-inspection
- ✓ Identifying the related construction part of a building (QR code, 3D-viewer)
- ✓ Filling in the self-inspection checklist related to the selected building component
- ✓ Feedback to project manager via RE Construct of the inspection

Extra:

- ✓ Post-commissioning self-inspection





STEP 7 SELF- INSPECTION

Summary: For the process step Self-Inspection the worker on-site is provided with the following means:

1. Self-inspection digital checklists
2. Registration functionality for observations, defects and escalations
3. Self-inspection applying AR technology

1

2

3

2. Geometry check of the groundsl

Is the geometrical accuracy to flatness within tolerance?
Yes

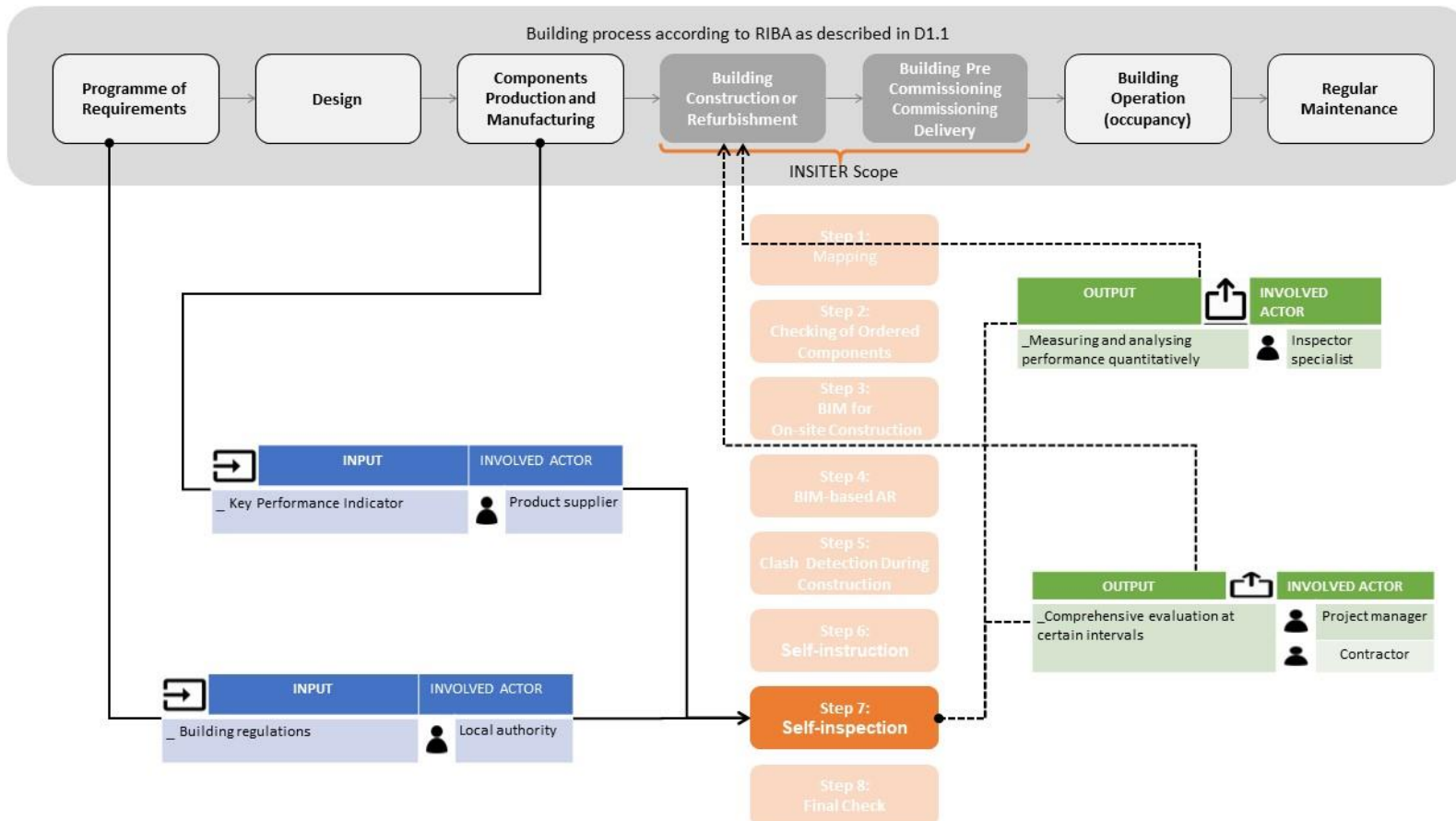
Is the geometrical accuracy to alignment within tolerance?
Yes

Is the angular misalignment <3mm?
Yes

Has laserscanning been applied?
Yes



STEP 7 – SELF- INSPECTION – ACTORS



STEP 7 SELF-INSPECTION QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS



INSITER step	INSITER description	Task name		SUB-task name(s)
7	Self-inspection during construction / refurbishment / maintenance process	Perform self-inspection during construction / refurbishment / maintenance process	Understand critical deviation and know what to do: start again, repair or talk with the building site manager how to solve the problem	7.1
			Control the quality of the façade with thermographic camera; communicate with the building site manager asap if the deviatons are critical	7.2

Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
Construction worker	How to work with the AR device to detect critical deviations in the façade with prefabricated panels	Which deviation or leakage is not correct? Which deviation or leakage is critical for the energy performance of the façade?	Understand critical deviation and know what to do: start again, repair or talk with the building site manager how to solve the problem
Inspector	How to use a thermographic camera, how to registrate thermographic images of agreed areas, how to identify thermal bridges, critical joints in the façade	Which deviation or leakage is critical for the energy performance of the façade?	Control the quality of the façade with thermographic camera; communicate with the building site manager asap if the deviatons are critical



7. Self inspection

STEP 7 – SELF-INSPECTION

Target: Verify the current installation and fill in checklists for further processing

The Story behind:

After the mounting of the façade elements or the MEP is completed, the construction worker will be enabled to verify his work through a checklist. A specialist (not the construction worker himself) performs a thermal scan on the finished installation, and the thermal image will be superimposed to BIM or AR for visual evaluation.

Screenshots:



14.3 Controle

Na de montage dient van elk VMRO gevellement te worden gecontroleerd of:

- De bevestigings delen op het juiste aansluitpunt zijn en goed functioneren.
- De beglazing intactheidsloos is.
- De aansluitingen op het bouwkundig kader correct zijn uitgevoerd.
- Het oppervlak vrij van beschadigingen is, met uitzondering van onderstaande.

Voor binnen geldt een bevestigingsafstand van 2 meter loodrecht op het oppervlak. Voor horizontale vlakken dient de bevestigings afstand te worden onder een hoek van 15 graden met het oppervlak. Voor buiten geldt: bevestiging vanaf maximaal binnen een afstand van 40' (horizontaal/verticaal) en te een afstand van ten minste 2 meter voor het oppervlak van de gevel. In alle gevallen vindt bevestiging plaats met het voorgespecificeerd slag en bij gebruik daglicht.

In het onderstaande overzicht is schematisch weergegeven hoe de bevestiging van gevelbevestiging plaats moet vinden.

Eenmaal afgeleverd mogen niet worden achtergelaten zijn. De VMRO gevelbouw controleert de montage als getoetste VMRO gevellement. Alleen geldt dit niet voor elementen die niet door de VMRO gevelbouw zijn gecontroleerd.

Na montage dient de VMRO gevelbouw te worden gecontroleerd. Fabrikant/leverancier worden opgeleid. Hieronder wordt aandacht getrokken voor de montage van de VMRO gevelbouw. De fabrikant/leverancier, de installatie van de gevelbevestiging. De fabrikant/leverancier, de installatie van de gevelbevestiging. De fabrikant/leverancier, de installatie van de gevelbevestiging. De fabrikant/leverancier, de installatie van de gevelbevestiging.



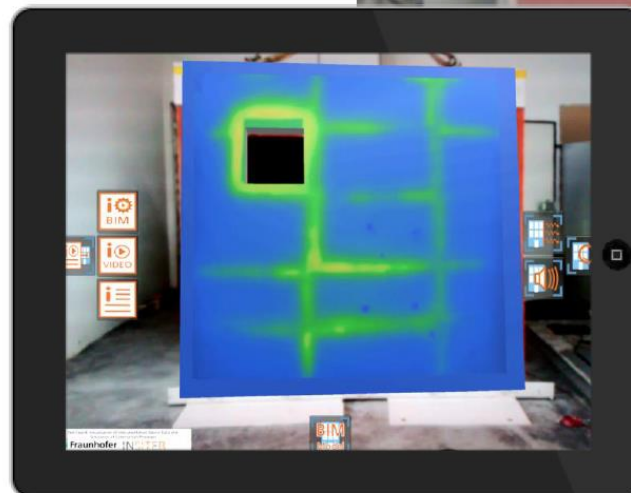
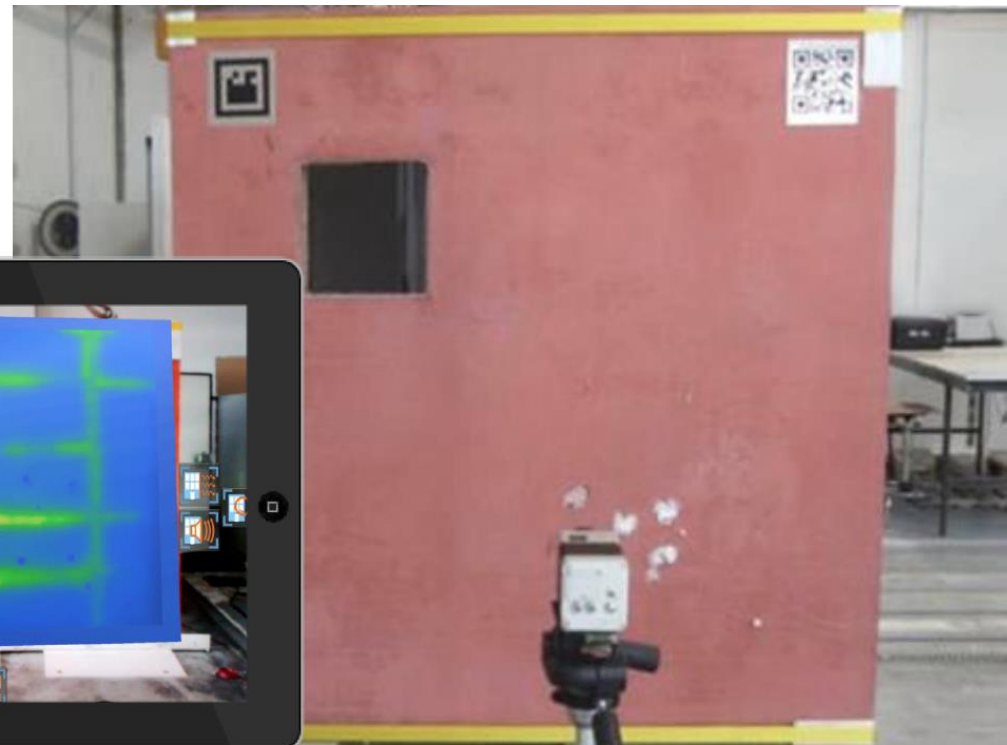
INSITER GUIDELINES



- **INSITER guidelines timeline for the construction worker**

Step 7: Self-inspection

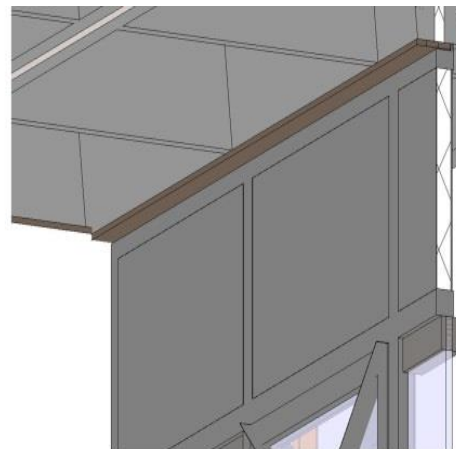
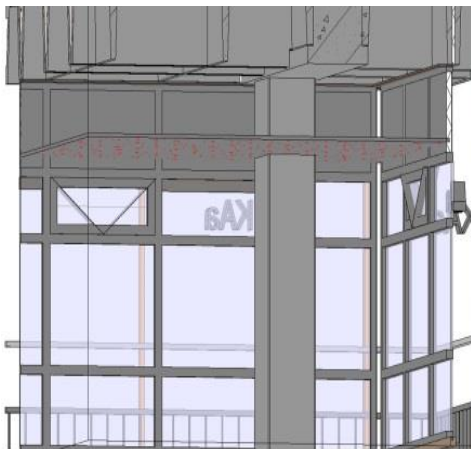
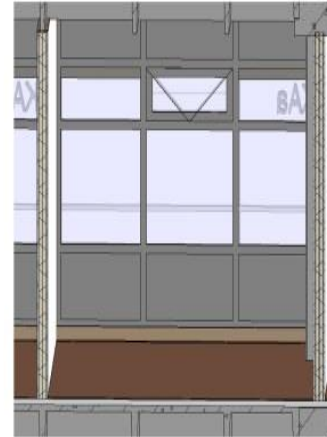
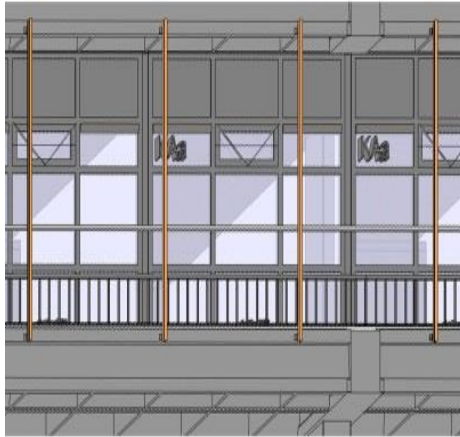
the worker on-site will check his own work with the help of checklists. Subsequently, if needed, he notifies a specialist to measure the exact performance using specialised equipment (ref. to WP2).



COMPARISON BETWEEN AS BUILT-AND AS-DESIGNED



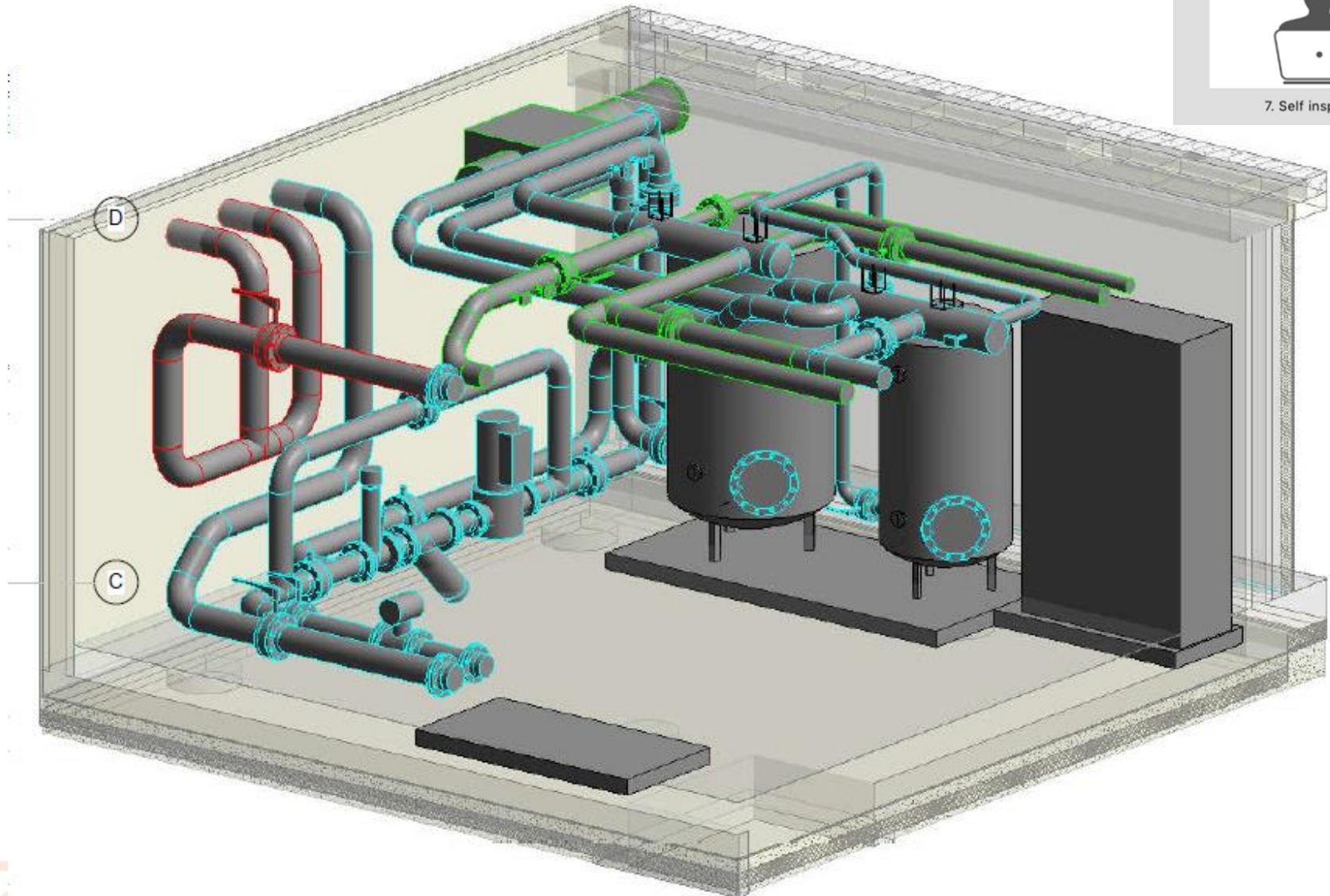
7. Self inspection



COMPLEXITY OF HVAC SYSTEM (HEAT PUMP)



7. Self inspection



(SELF-)INSPECTION LEVELS

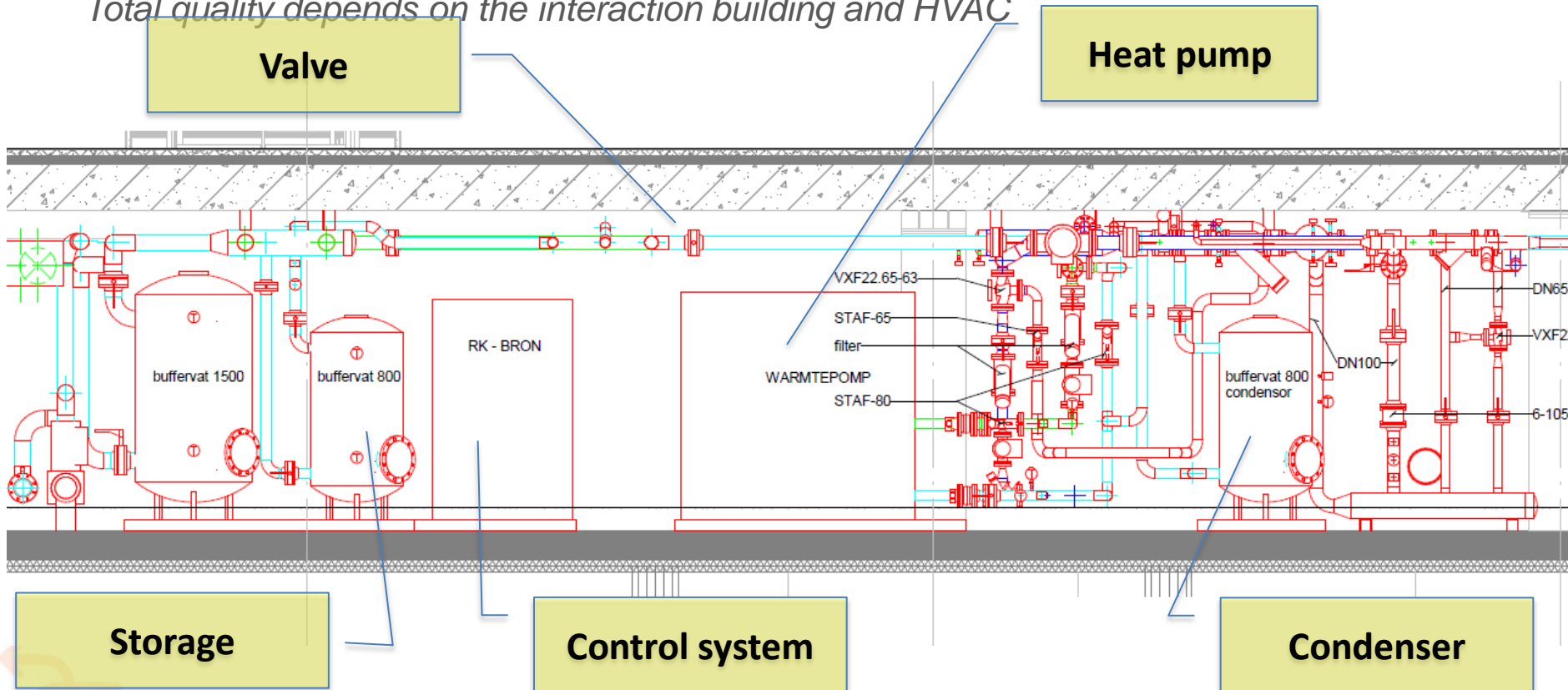


Total quality depends on the quality of all individual components and (sub)systems

Total quality depends on the interaction between the individual systems

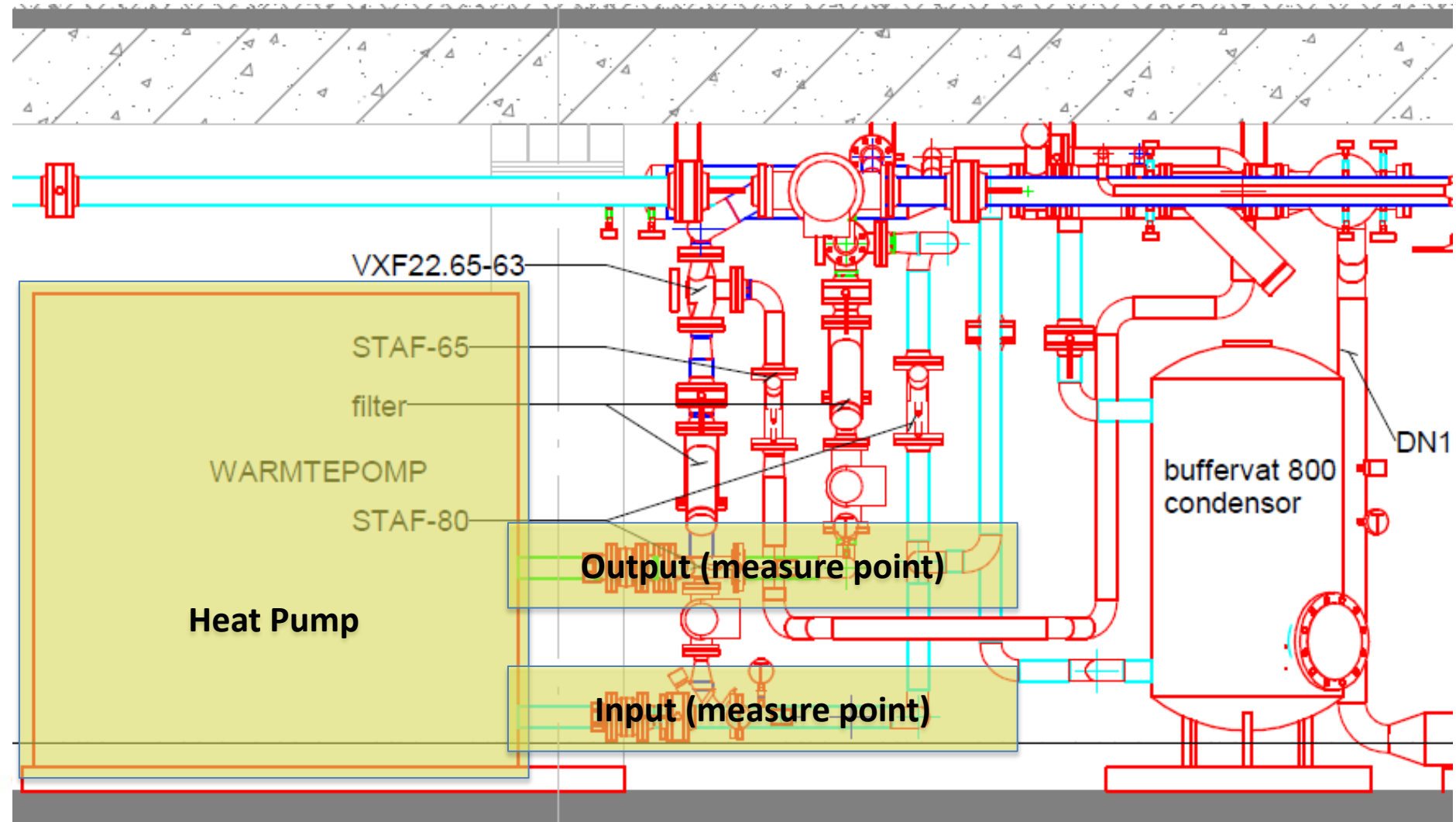
Total quality depends on the control systems in the building (the brain)

Total quality depends on the interaction building and HVAC



(SELF-)INSPECTION LEVELS

Inspection of the heat pump, based on input and output (design) parameters



ADVANCED ANALYTICAL TECHNIQUES ENERGY-EFFICIENCY



Explanation of simulation based self-inspection of HVAC/MEP systems

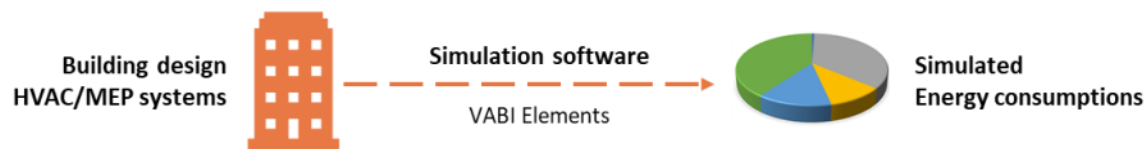


ADVANCED ANALYTICAL TECHNIQUES ENERGY-EFFICIENCY

Results concerning advanced analytical techniques beyond state-of-the-art in practice for (self-)inspection during construction

Simulation-based self-inspection of HVAC/MEP systems

1. Starting point: understanding building performance and major influencing systems



2. Re-prioritizing lists of common errors and critical components
3. Setting-up a simulation strategy

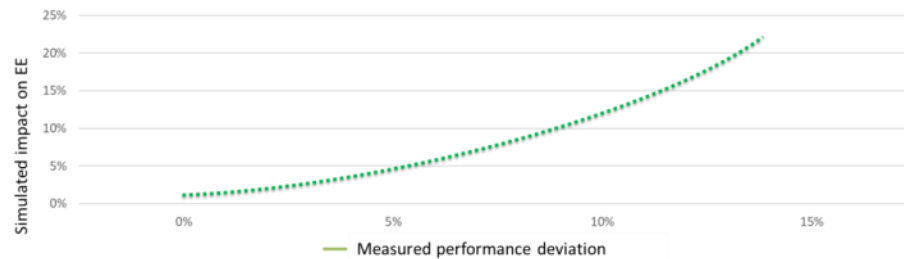


ADVANCED ANALYTICAL TECHNIQUES ENERGY-EFFICIENCY

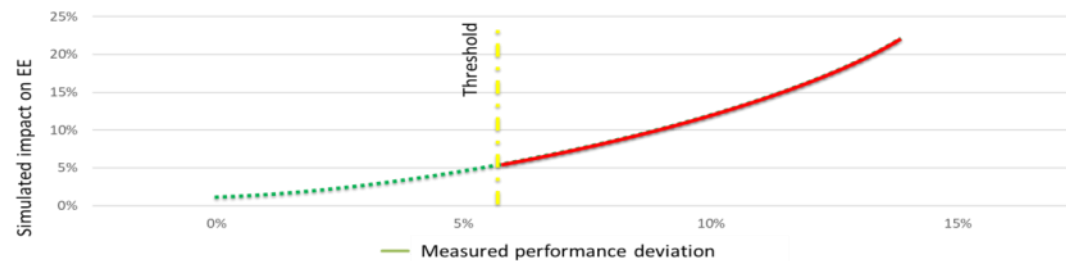
Results concerning advanced analytical techniques beyond state-of-the-art in practice for (self-)inspection during construction

Simulation-based self-inspection of HVAC/MEP systems

4. Simulating performance deviations



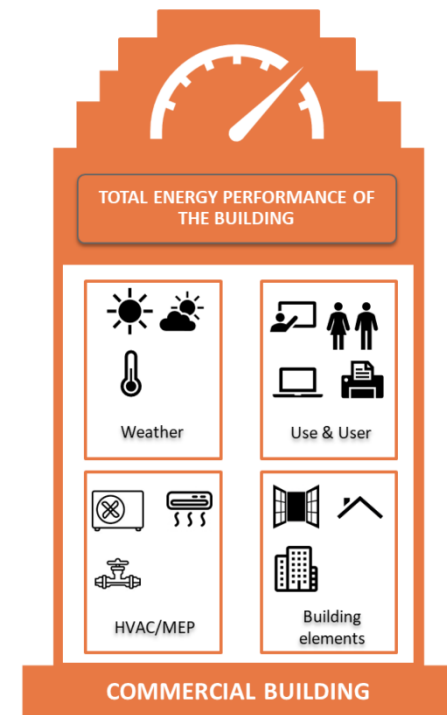
5. Determination of thresholds



ADVANCED ANALYTICAL TECHNIQUES ENERGY-EFFICIENCY

Results concerning advanced analytical techniques beyond state-of-the-art in practice for (self-)inspection during construction

PRACTICAL EXAMPLE of simulation-based self-inspection of HVAC/MEP systems





7. Self inspection

CHALLENGES IN CURRENT INSPECTION PRACTICES

Multidisciplinary:

Inspection performed by an expert team (MEP) not by one expert.

Interaction between different components:

Components of the heat pump do influence each other. Not easy to point out the right cause.

Interaction with building elements and other HVAC systems.

Quality and performance of distribution circuit influence the efficiency of the heat pump system.

Real performance

Real performance is related to quality of building elements, whole HVAC/MEP and user behavior.



DEVELOPMENT CONSIDERATIONS

A generic process:

Usable for different types of project and regardless of manufacturers.

Ease of use:

Not burdening the inspection process. Innovative but practice. No additional knowledge required.

Effectiveness

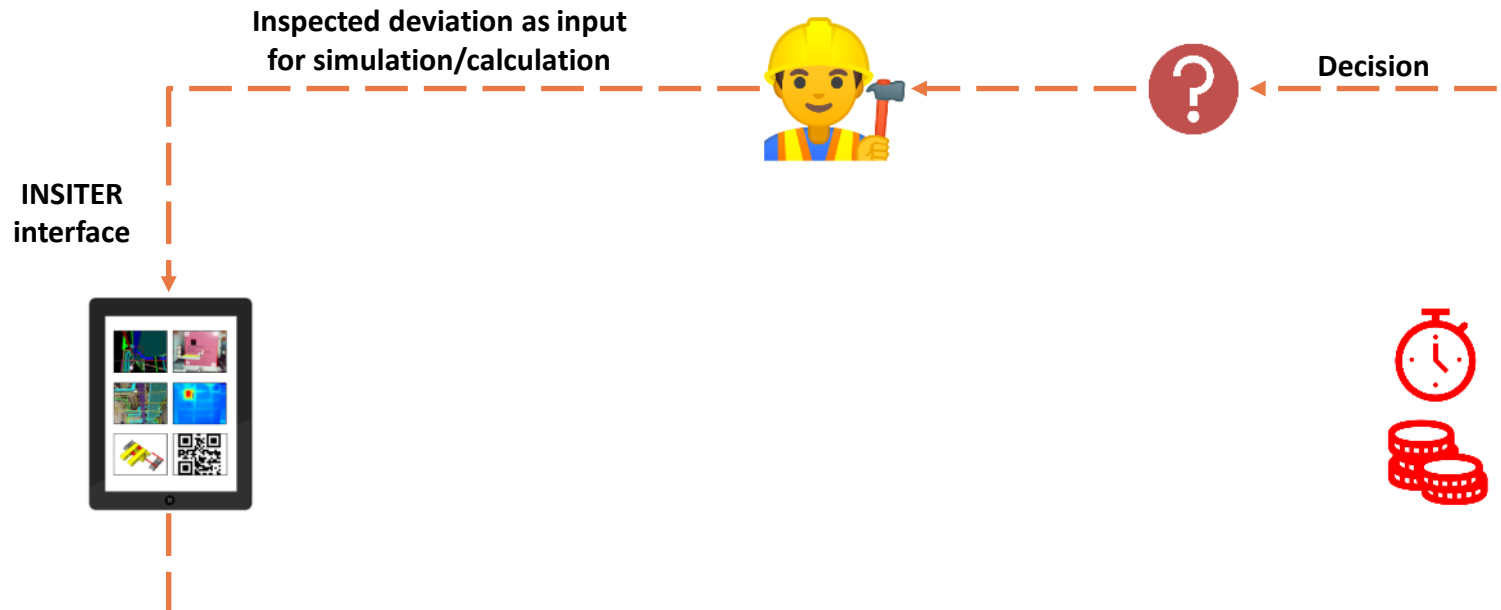
Related to relevant critical components/systems.

Efficiency

No additional time and resources required on-Site.



CHALLENGES REGARDING SIMULATION USE FOR INSPECTION



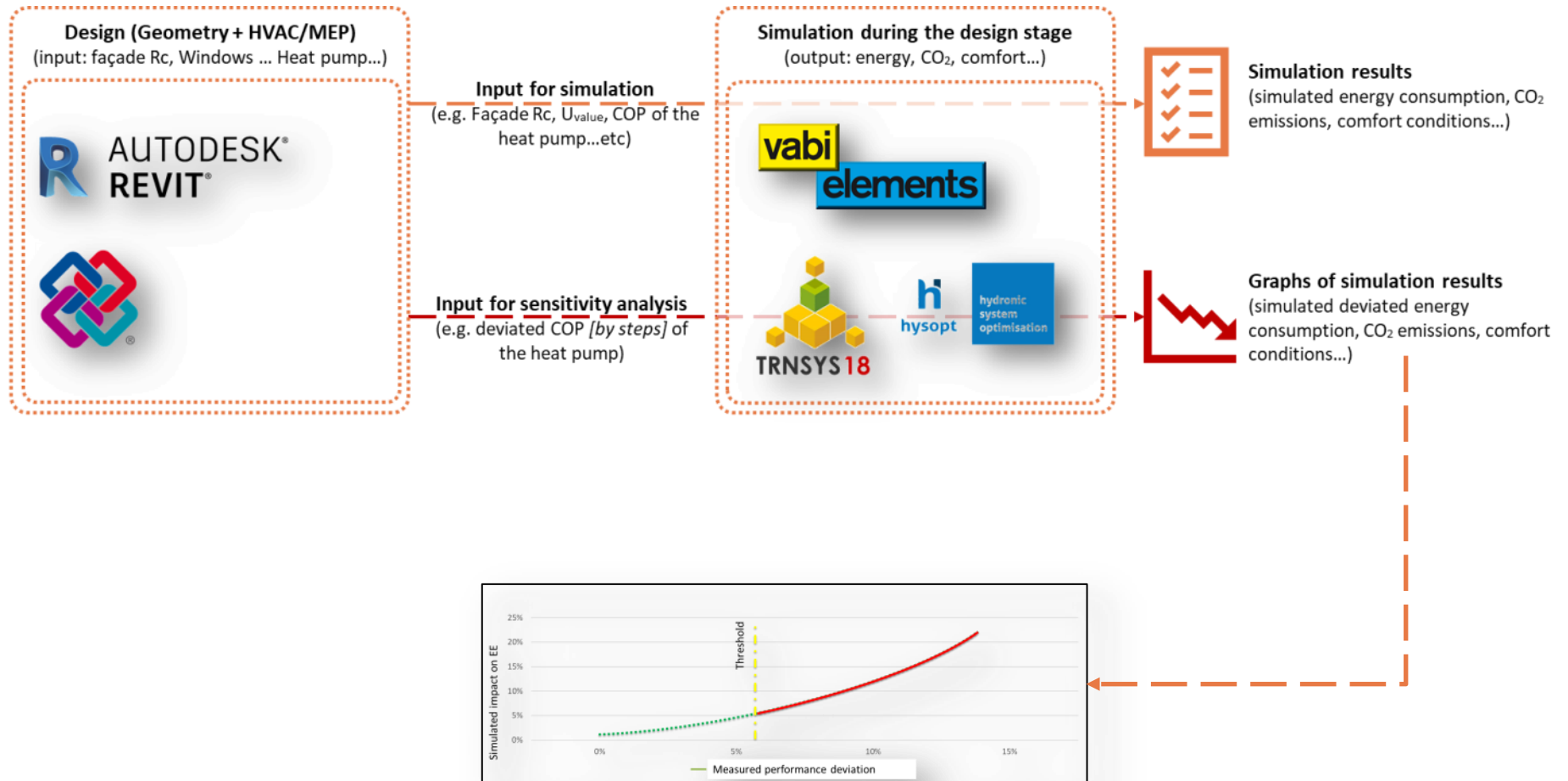
Conclusions:

- Move the simulation part to the design stage as designers use simulations to create scenarios over possible deviations and related impact.
- The simulation will be based on the critical components/systems.

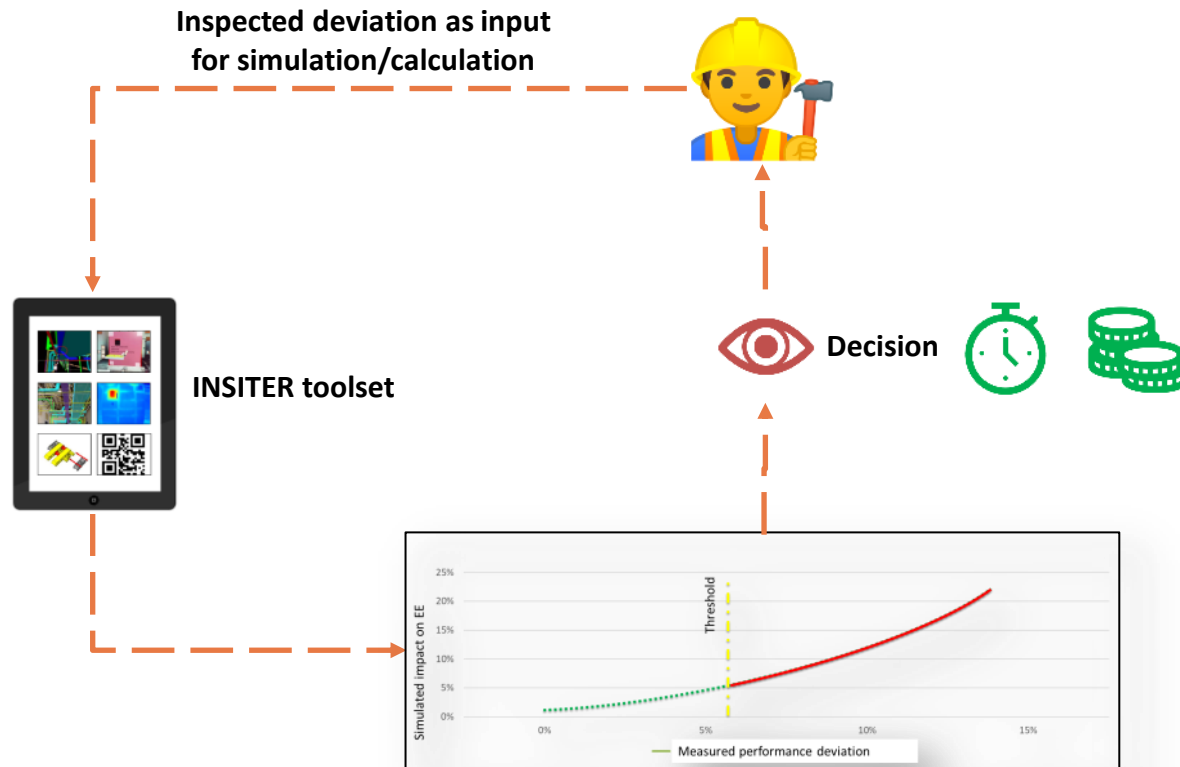
Conclusions:

- Move the decision to well-qualified personnel (engineer) and decision makers (building owner or supervisor).
- Decide on the accepted performance deviation for each critical component.
- Create a graph to be used by the workers.

NEW APPROACH SIMULATION-BASED INSPECTION (DESIGN STAGE)



NEW APPROACH SIMULATION-BASED INSPECTION (REALISATION STAGE)



Performance deviation graph and related thresholds as result of the design stage



NEW APPROACH: (RE-)PRIORITIZING CRITICAL COMPONENTS

Building design
HVAC/MEP systems



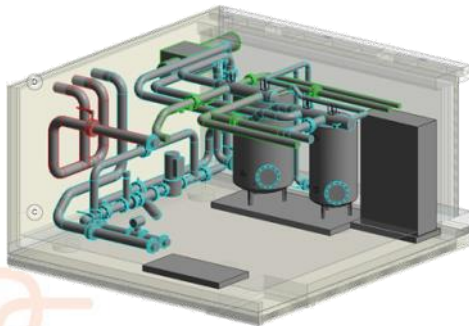
Simulation software

VABI Elements

BUILDING 2

Space heating is almost 50% of the total energy consumption of the building. Regarding energy performance, more attention to be paid for inspecting heating systems.

In this case more attention for the heat pump system. And specially for the COP of the heat pump.



Space heating
52%

Others
16%

Cooling
4%

Kitchen
5%

Lighting
14%

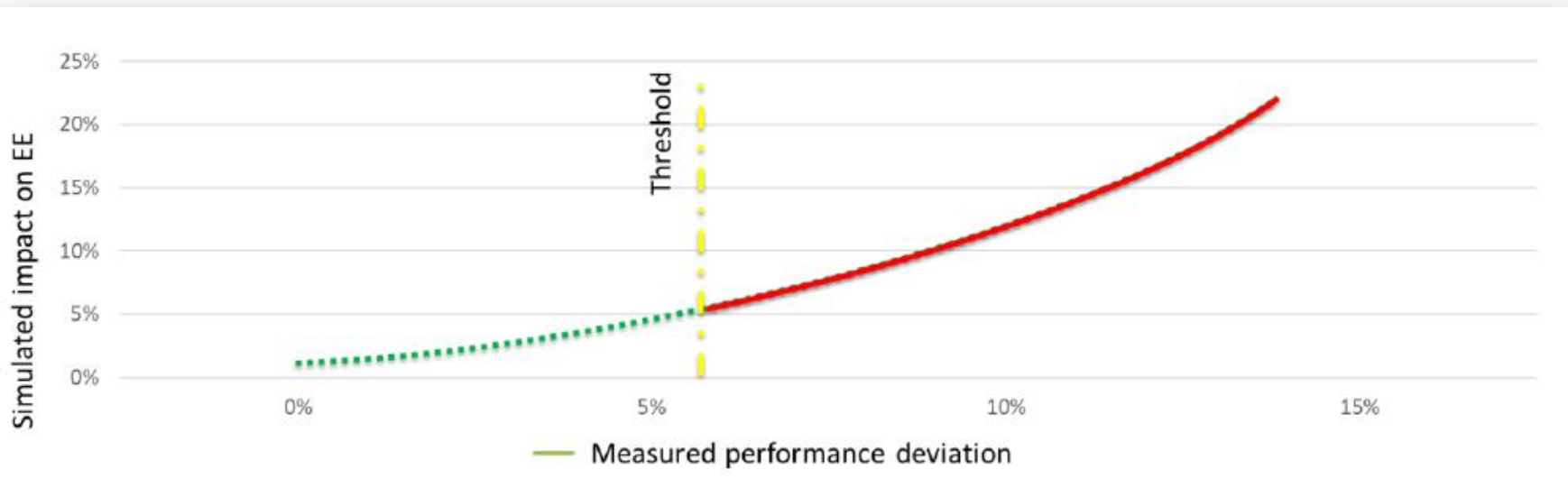
Hot water
9%

Simulated
Energy consumptions



7. Self inspection

NEW APPROACH: SIMULATION BASED GRAPHS FOR SELF-INSPECTION



ADVANCED ANALYTICAL TECHNIQUES ENERGY-EFFICIENCY






Conclusions:

- Providing new measuring and diagnosis solutions for self-inspection by HVAC/MEP workers.
- Supports workers taking the right decision in case of deviations under special conditions
- Providing new simulation-based diagnosis approach to diagnose the impact of performance deviation on related KPI's and total building quality.
- No heavy simulation techniques which requires heavy computing capacity and plenty of time to run simulations

ENERGY MODULE



Energy consumption as simulated based on design <i>{Note: Previously calculated result using TRNSYS, VABI, or other tool}</i>			(Self) inspection performed during construction		Inspection findings			
Scale / level	Type	Energy calculation (quantity)	Inspection / instrument type	Result / data output type	Deviation from design (Yes/No)	Extent of deviation (Major/ Minor)	Estimated impact on energy performance (traffic light indicators: green = within threshold; orange = almost critical; red = critical)	Estimated quantified impact on energy performance (in percentage, if possible)
Critical components level								
Building component	<i>5 critical components</i>	<i>value</i>	<i>Type of inspection on critical building component level</i>	<i>Inspection report per critical building component</i>	<i>Yes/No</i>	<i>No Minor Major N.A.</i>	 <i>GREEN ORANGE RED + motivation</i>	<i>Estimation EE in % more or less</i>
HVAC /MEP system	<i>4 critical components</i>	<i>value</i>	<i>Type of inspection on critical installation component level</i>	<i>Inspection report per critical installation component</i>	<i>Yes / No</i>	<i>No Minor Major N.A.</i>	 <i>GREEN ORANGE RED + motivation</i>	<i>Estimation EE in % more or less</i>
Building level								
Building / case	<i>Specific building case</i>	<i>Value (... kWh)</i>	<i>Type of inspection on building level (Thermal scan, laser scan, ...)</i>	<i>Comprehensive report</i>	<i>Yes/No</i>	<i>No Minor Major N.A.</i>	 <i>GREEN ORANGE RED + motivation</i>	<i>Estimation in % performance on building level due to suboptimal performance on component level</i>

Simulation/ calculation during design phase

Inspection during construction

Deviations between as designed and as built and impact on energy performance

NEW GUIDELINE STEP 7 – SELF-INSPECTION

New critical EeB component: ...

...

Step 1:
Mapping

Step 2:
Checking of Ordered
Components

Step 3:
BIM for On-site
Construction

Step 4:
BIM-based AR

Step 5:
Clash Detection
during Construction

Step 6:
Self-instruction

Step 7:
Self-inspection

Step 8:
Final Check

INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

E.g.:

- Correctness and air tightness of the joints
- Correct appliance of the water sealing membranes
- Water/air flow issues
- Incorrect connections to other components
- Incorrect settings or adjustments
- ...

Key activities

E.g.:

- Use the right inspection protocols*
- Take a picture of the work done, for each check
- Add notes, if necessary
- Write down (measured) value
- ...

Special attention

E.g.:

- Initiate measurements, if required
- Ask for feedback from site supervisor for detected deviations
- Consult manufacturer in case of inconsistencies of the components
- ...

Technical information

E.g.:

- Checklists / inspection protocols (XLS)
- Supporting photos and figures
- Supporting instructions
- ...

NEW GUIDELINE STEP 7 – SELF-INSPECTION

New critical EeB component: ...

1. What

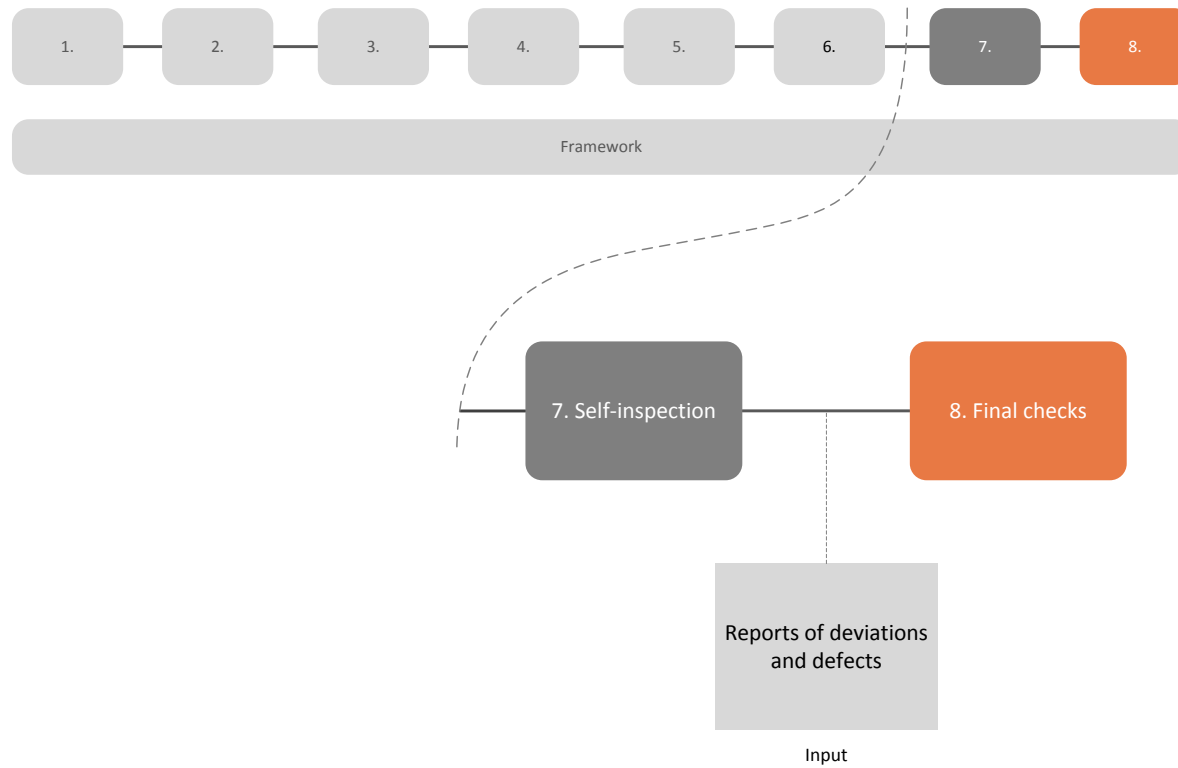
Example of an inspection protocol for an air handling unit, after assembly,
executed by the M

3. Who

2. When

Ref.#	Question	Opt.1	Opt.2	Opt.3
V02.01	Are lockable work switches fitted?	yes	no	
V02.03	Is the air handling unit earthed?	yes	no	
V02.04	Is the power cable for the frequency-controlled motor in a symmetrical shielded cable?	yes	no	dna
V02.07	Is the overpressure siphon correctly installed (including siphon height)?	yes	no	
V02.08	Is the vacuum siphon correctly applied (including siphon height)?	yes	no	
V02.19	Is the air handling unit protected against rain and dust penetration before being connected to the air ducts?	yes	no	dna
V02.20	Is air handling unit protected against the effects of the weather and the entrance of vermin and the like?	yes	no	
V02.21	Is there storage of materials and tools in the air handling unit during the construction process?	no	yes	
V02.35	Are air ducts supported on the construction of the air handling unit?	no	yes	

STEP 8 – FINAL CHECKS



STEP 8 – FINAL CHECKS



Keeping track real-time of the construction process through condensed information

SharePoint

BROWSE PAGE ITEMS LIST

INSITER Intuitive Self-Inspection Techniques INSITER Consortium Website

- Home
- Guidelines
- Documents
- Manuals
- Recent

Welcome to the INSITER collaboration platform. This platform serves as a central hub to exchange information and data throughout the INSITER process, and is both human as well as machine readable.

The platform is hosted by DEMO Consultants. If you do have any questions or need assistance please contact: info@demobv.nl

The INSITER Toolset

1. Mapping
2. Checking
3. On-site BIM
4. BIM-based AR
5. Clash detection
6. Self-instruction
7. Self-inspection
8. Final Checks

Framework

8. Final Checks

Tools

RE Dashboard

Description:
The RE Dashboard application provides a visual representation of the most important information needed to achieve one or more objectives consolidated and arranged on a single screen. The information can be viewed at a glance. You can control and monitor based on the information displayed on the dashboard using Key Performance Indicators (KPIs). It is applied by the project manager who frequently checks the KPI values presented on the dashboard in order to monitor the process and to take decisions in time when needed.

Metadata:
[Click here to access RE Dashboard](#)

Devices





8. Final check

STEP 8 – FINAL CHECKS

Target: Quality, time and cost evaluation by the Construction Managers

The Story behind:

The construction worker completes his assignment by reporting on the finished work, including some photos taken on-site. He should also note errors or doubts, if any, into his digital report through the mobile app. The site supervisor opens this report, and gives approval or asks for re-work. The approved works appear on a common dashboard showing the level of quality and performance during the on-site process.

Screenshots:



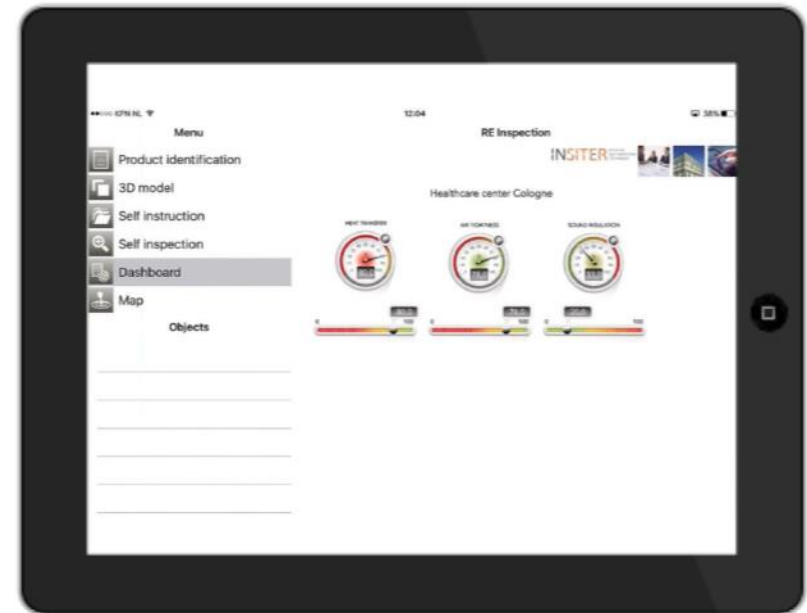
INSITER GUIDELINES



- **INSITER guidelines timeline for the construction worker**

Step 8: Final check

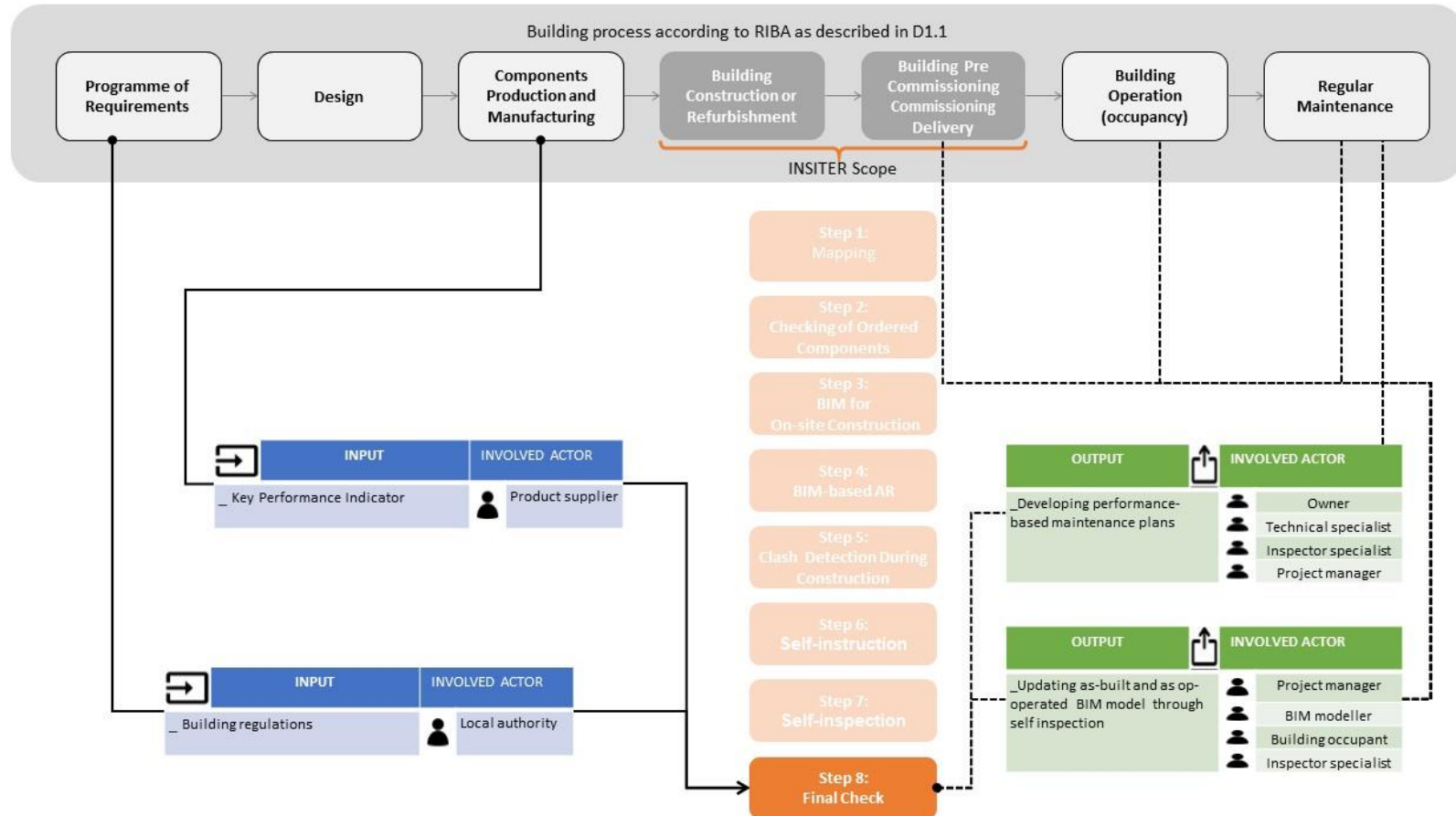
final evaluation of the work to be delivered. The construction worker completes his assignment by reporting on the finished work, including some photos taken on-site. He should also note errors or doubts, if any, into his digital report through the mobile application. The site supervisor opens this report, and gives approval or asks for rework. The approved works appear on a common dashboard (off-site) showing the level of quality and performance during the on-site process. Quality, time and cost evaluation can be monitored like that by the construction managers.





8. Final check

STEP 8 – FINAL CHECKS – ACTORS



STEP 8 FINAL CHECKS QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS

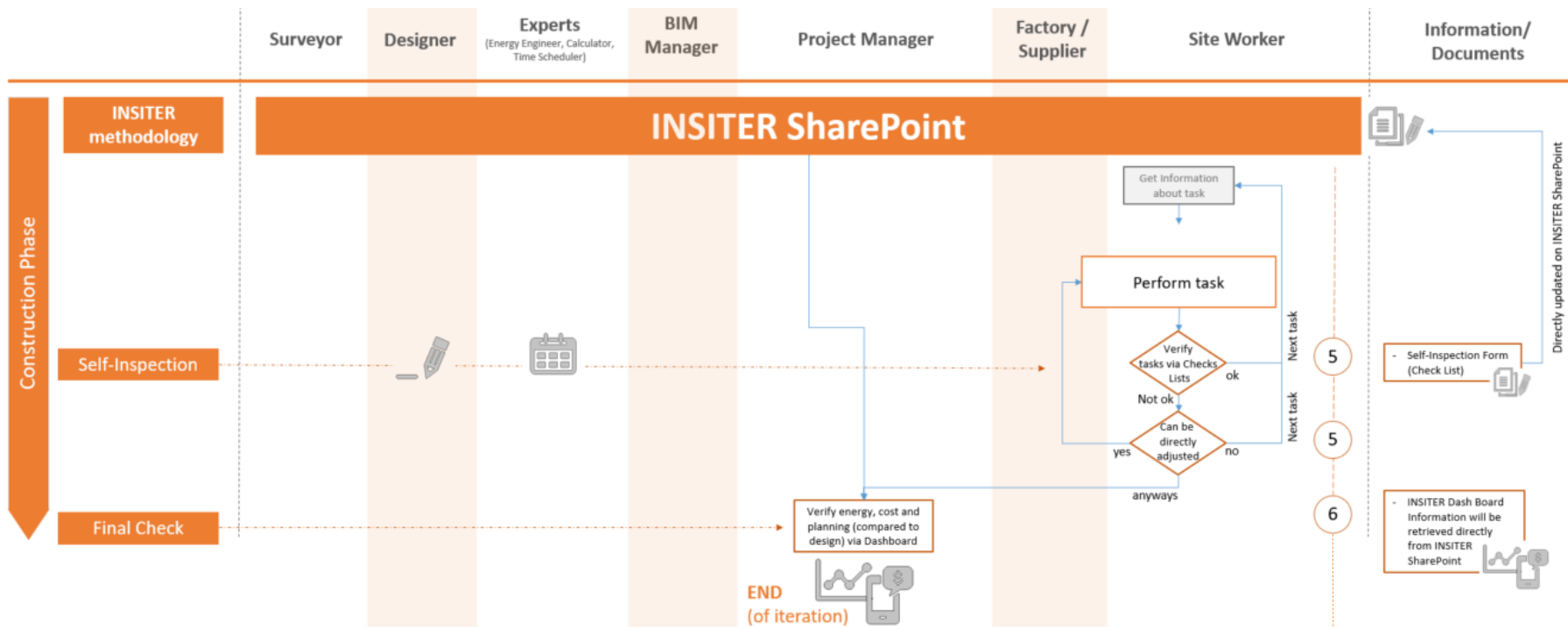


8. Final check

INSITER step	INSITER description	Task name		SUB-task name(s)
8	Self-inspection and self-instruction during pre-commissioning, commissioning and project delivery	Perform self-inspection and self-instruction during pre-commissioning, commissioning and project delivery	Control the delivered documents and check the documents and façade unselective, show unselective recent thermographic images to the commissioner	8.1
			Control the delivered documents and recent thermographic images	8.2

Actors	K1: List of what to know (knowledge)	K2: List of what to understand (skill)	K3: List of what to be able to do (competence)
Building site manager	Critical joints in the facade, how to check the delivered documents about self-inspection of the façade	Which deviation or leakage is critical for the energy performance of the façade?	Control the delivered documents and check the documents and façade unselective, show unselective recent thermographic images to the commissioner
Commissioner	Technical specifications of the façade, Critical joints in the façade, how to check the delivered documents	Which deviation or leakage is critical for the energy performance of the façade?	Control the delivered documents and recent thermographic images

VALIDATING THE RESULTS & ANALYZING THE PROJECT



INSITER prevents:

- 1: Errors due to lack of time for construction
- 2: Errors due to wrong delivered / damaged components
- 3: Errors due to bad preparation / insufficient information
- 4: Errors due to different site situation
- 5: Errors due to bad performance
- 6: Bad project management due to outdated information

NEW GUIDELINE STEP 8 – FINAL CHECK

New critical EeB component: ...

...

Step 1:
Mapping

Step 2:
Checking of Ordered
Components

Step 3:
BIM for On-site
Construction

Step 4:
BIM-based AR

Step 5:
Clash Detection
during Construction

Step 6:
Self-instruction

Step 7:
Self-inspection

Step 8:
Final Check

INTERVENTION DESCRIPTION

DATA & INFORMATION

Main critical points

E.g.:

- No critical errors left
- All deviations within thresholds/tolerances

Key activities

E.g.:

- Reassure that all steps are finished and documented
- Make final remarks about deviations and inconsistencies
- Make final remarks about possible improvements
- Fill in questions for evaluation

Special attention

E.g.:

- Final assessment report is generated by INSITER App.

Technical information

No data needed on forehand. All necessities will be generated during formal steps.

BENEFITS INSITER & THE 8-STEPS METHODOLOGY

- The applied 3D models have a high degree of quality through clash detection, model checking and point cloud processing steps incorporated in the process
- Workers on-site know exactly which tools to use for a certain step of the process
- Workers on-site have instruction material of various kinds available
- Workers on-site have all kinds data available and at hand (documents, video's, interactive step-by-step)



BENEFITS INSITER & THE 8-STEPS METHODOLOGY

- Workers on-site can apply Augmented Reality technology for comparing the reality against the model and animated training material
- Workers on-site can check their own work via digital checklists
- Workers on-site can communicate via the tools (observations, defects and escalation)
- Project managers are supported in their decisions by monitoring the KPI dashboard



COLOPHON

November 2018

Training 8-steps

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ISSO

CO-AUTHORS: WP 1 - 5

VERSION: 3.0



INSITER



THIS RESEARCH PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S H2020 FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION UNDER GRANT AGREEMENT NO 636063.

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TECHNIQUES