ICONS

E-GUIDE
"ROAD TO DIGITALIZATION FOR 4.0 WORKERS: METHODS AND TOOLS"

Co-funded by the Erasmus+ Programme of the European Union

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WESTDEUTSCHER HANDWERKSKAMMERTAG

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ICONS

EXECUTIVE SUMMARY

This document aims to provide all relevant information about the structure and functioning of the two BIM-oriented training tools specifically targeted to blue collars and developed within the ICONS - Innovation in CONstruction Sites project.

It is meant by use of trainers and VET providers in the construction sector, while empowering blue collars in understanding BIM-designed projects.

After an introduction of the ICONS project purposes and methodology applied to build the two BIM training tools, a chapter is dedicated respectively to the description of the training course and the innovative app.

1. THE ICONS PROJECT

1.1 THE CHALLENGE: TOWARDS A MORE COOPERATIVE AND DIGITAL WORKING ENVIRONMENT IN THE CONSTRUCTION SECTOR

The ICONS project started in December 2019 and will be completed at the end of February 2022. The project is co-funded by the ERASMUS+ programme.

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It aims **to improve the working quality in the construction sector** by increasing the workers' digital skills and BIM knowledge; and, consequently, to **promote the productivity and sustainability** of the construction sector in Europe.

More specifically, the goal of the project is to create a **tailor-made training course and App,** in order to translate the highly technical and complex set of information that is contained in a BIM structure into a modality which can be read, understood and easily processed by non-professionals.

1. THE ICONS PROJECT

ICONS action plan includes the consolidation of **strategic and operational cooperation** between actors within the construction sector, as well as the **maximization of communication flow** between designers, site managers and blue collar workers.

At the core of the project there are **three Intellectual Outputs (IOs):**

- IO 1: «Compliant BIM-oriented training course for workers 4.0 in the construction field». This training is conceived for workers in the construction sector and aims to improve their skills in reading and processing technical information in accordance with the integrated project system introduced by the BIM.

- IO 2: «App for workers 4.0 in the construction field». An innovative App specifically designed for blue-collar workers on building sites, which will serve as a pedagogical tool with clear and ready-to-go instructions for simple key actions that workers might need to work on building sites.

- IO 3: «E-guide "Road to digitalization for workers 4.0: methods and tools"». The e-guide will collect and make available the contents of the IO1 and the main indications on how to use the App (IO2); it will be available in Italian, German, English and Spanish.

1. THE ICONS PROJECT

ICONS also contributes to:

- **Increase digital skills and knowledge** of the workers on the key information and software regarding the construction life cycle. The enhancement of digital skills is known to increase **workers' competitive edge** in the labour market, besides being conducive to the **improvement of working conditions, performance efficiency and communication flows** between the different actors working within the building construction cycle.

1.2 THE METHODOLOGY

ICONS project is developed along two main phases, one of preparation and the other of testing, leading to the development of the tailor-made BIM training course and app for blue collar workers use.

During the **preparatory phase**, the consortium carried out desk analyses at local levels to understand the present level of BIM knowledge among blue collar workers and to investigate their needs & demands in relation to the training topics. The **contents of the training modules** have been defined and described accordingly, while, in parallel, **the structure of the App** is also being developed in its virtual elements, interaction processes and graphic aspects.

Once both a pilot version of the training module and the App have been finalized, an online

1. THE ICONS PROJECT

International Training for Trainers was held, where expert trainers from project partners' countries were instructed on how to use the training modules and on the functioning of the App, as well as on how to measure and refer to feedback from the learners.

In the **second phase**, **national training events** and **pilot tests** were implemented at local levels by those same expert trainers to validate and adjust the BIM learning tools previously developed within the project. In particular, national training events have been addressed to both students and blue collar workers in the construction sector, including a final examination to test participants' comprehension of the subject matter and a questionnaire to evaluate the quality of contents and teaching methodology; while pilot tests have been conducted by blue collar workers.

Finally, after the completion of all training modules and the conclusive validation of the App, a series of **local events** were organized by all partners to disseminate project results towards local, national and international stakeholders within the construction sector.

ICONS lead partner "Scuola Costruzioni Vicenza Andrea Palladio", in addition, developed the present **e-guide** gathering instructions and recommendation about the training module and the App.

2. COMPLIANT BIM-ORIENTED TRAINING COURSE FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

The realisation of the BIM oriented training course followed two phases: a **preliminary analytical phase** and a **development phase**.

In the **preliminary phase**, the following analyses were conducted, fundamental for the definition of the contents of the training module:

- **Analysis on the state of the art of BIM in the European project partner countries (Italy, Spain, Slovenia, UK, Germany).** Analysis carried out by each partner at national level about the legal and educational framework on the current adoption of BIM. On the occasion of the KoM (Düsseldorf, February 2020), CU, as IO1 partner leader, presented the results obtained from this analysis and in particular a fragmentation in terms of knowledge, training and application of BIM among the EU project partner countries was highlighted.

- **Analysis of educational needs.** Analysis conducted by each partner at local level, through the administration of questionnaires addressed to entrepreneurs and workers in the construction sector, with the aim of identifying the challenges and difficulties in the understanding and implementation of BIM. The questionnaires were carried out by CU and SCVAP, in collaboration with the

- **Analysis on active training courses on BIM in the partner countries.** Specific analysis on the training programmes available in the partner countries at regional and national level, with indications on contents,

2. COMPLIANT BIM-ORIENTED TRAINING COURSE FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

and Revit).

The **theoretical part** consists of 9 chapters, for a total of 81 slides, focused on the main concepts and avoiding an excess of information.
The table of contents includes hyperlinks, so that readers can be directly redirected to the relevant chapter(s). In addition, a glossary has been included within the module with the main definitions. The theoretical module is available in all project languages (English, Italian, Slovenian, Spanish and German).
In Annex I, it is possible to find the complete training module.

In the **practical part**, guide videos showing blue collars how to navigate in the model produced by professionals using BIM software, as described in the following chapter.
There are several applications usable in this context, but unfortunately the market is still not perfectly ripe to use the IFC file format on the building site, so the most affordable solution was to use the Project viewer from the most used 3D authoring tools: BIMx as a viewer for ARCHICAD projects and A360 for Revit ones.

2. COMPLIANT BIM-ORIENTED TRAINING COURSE FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

objectives and training results. Among the main results, it is underlined that the existing training proposal is often dedicated to designers and not to site workers and/or other professionals involved in the construction and renovation cycle.

Based on the results of the above analyses, the **development phase** of the training module was launched. The module is targeted to blue collar workers, also in response to the training gap that emerged in the analysis of the training courses active in the European project countries.
Moreover, despite the fragmentation, in all project countries there is little (if any) knowledge of BIM among workers.

Concerning the contents, an **introductory approach** to the topic was applied, including in the training module basic notions about what BIM is, what it is used for, how to use it, what are the advantages, selecting only the notions and functions of BIM that are useful for workers to perform their tasks, in order to avoid an information overload. A **language suitable for any professional** working in the construction sector was preferred, with a combination of text, images and videos, in order to make the module more dynamic and attractive, as well as easy to read, understand and consult.

The module has been structured in two parts: theoretical with the main notions on what BIM is; practical with 43 video tutorials showing how to navigate the BIM model using two of the most popular software at European level (Archicad

3. VIDEO

3.1 INTRODUCTION

The **practical part** includes 43 guidance videos, of which 24 are dedicated to the use of GRAPHISOFT BIMx to navigate in ARCHICAD models, and 19 to the use of Autodesk A360 to navigate in models created in Revit. The videos illustrate how to use some specific functions of the 2 BIM model viewers, such as navigating in the model, extracting information and sending comments to the designers. The videos show the process of implementing these functions by means of a cursor indicating the buttons and/or the working areas, including an accompanying text describing the movement or a specific request for action (e.g. type the button, zoom, etc.).

2. 2 BIMX BASICS

1. .1 FIRST STEPS

App download

bimx can be downloaded for mac os x, windows but we are especially interested in the ios and android versions (it's even possible to navigate a model in the browser in the https://bimx.graphisoft.com website).

Both the IOS and Android versions are free to download but are available as a pro.

3. VIDEO

Differences between bimx and bimx pro

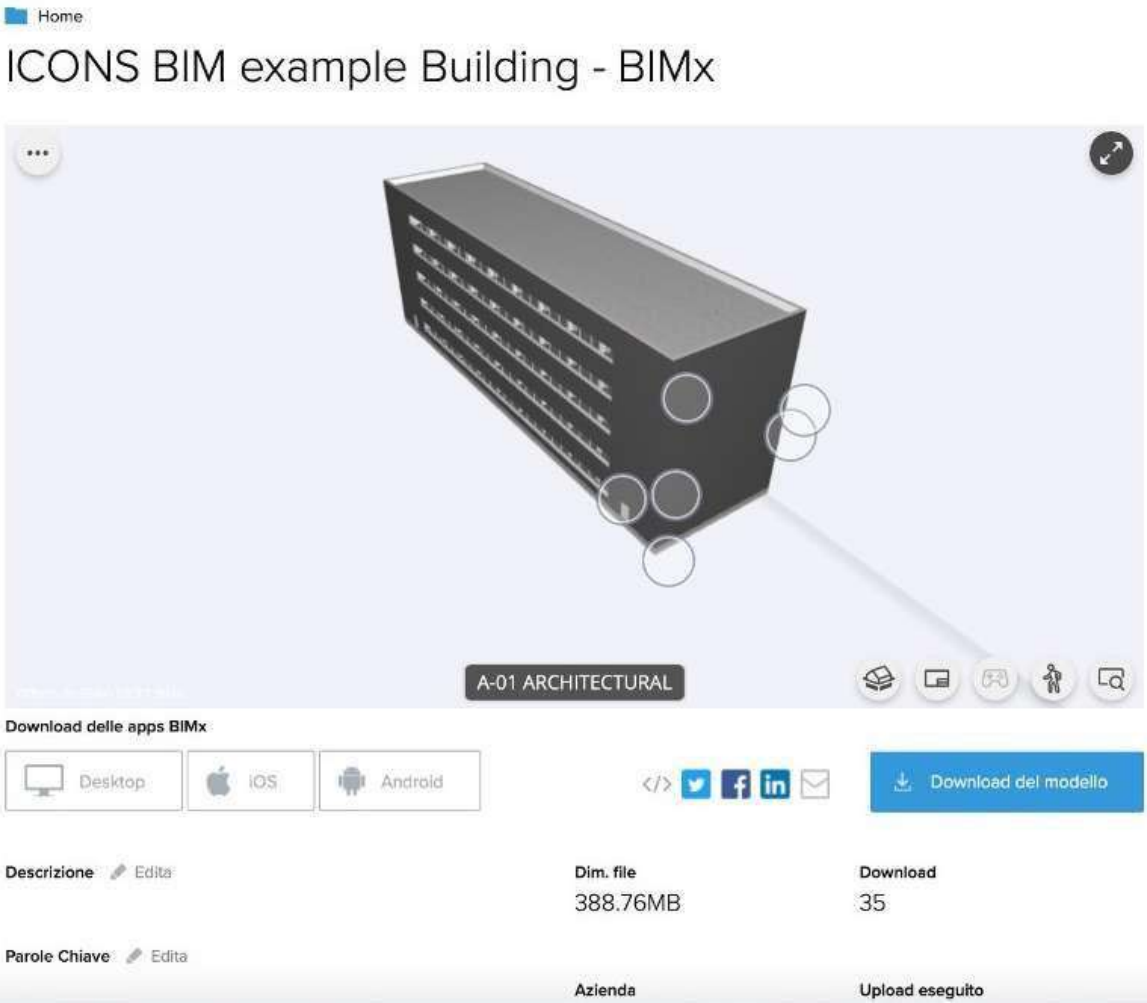
Both the standard and the pro version of bimx give the possibility to navigate in models exported by archicad and watch layouts provided by professionals.

The pro version even provides the possibility to to print directly from bimx, to save favourite views for presentation and to communicate with teamwork users if they are using bimcloud “pro” (the paid version of the app to let multiple users work contemporary on the same project).

More infos at: https://community.graphisoft.com/t3/visualize-articles/bimx-license-types/ta-p/304184

How to obtain bimx models and updates

BIMx models can be shared cloud-via through the platform bimx model transfer (https://bimx.graphisoft.com) or using a shared f



3. VIDEO

older like dropbox, g-drive etc.

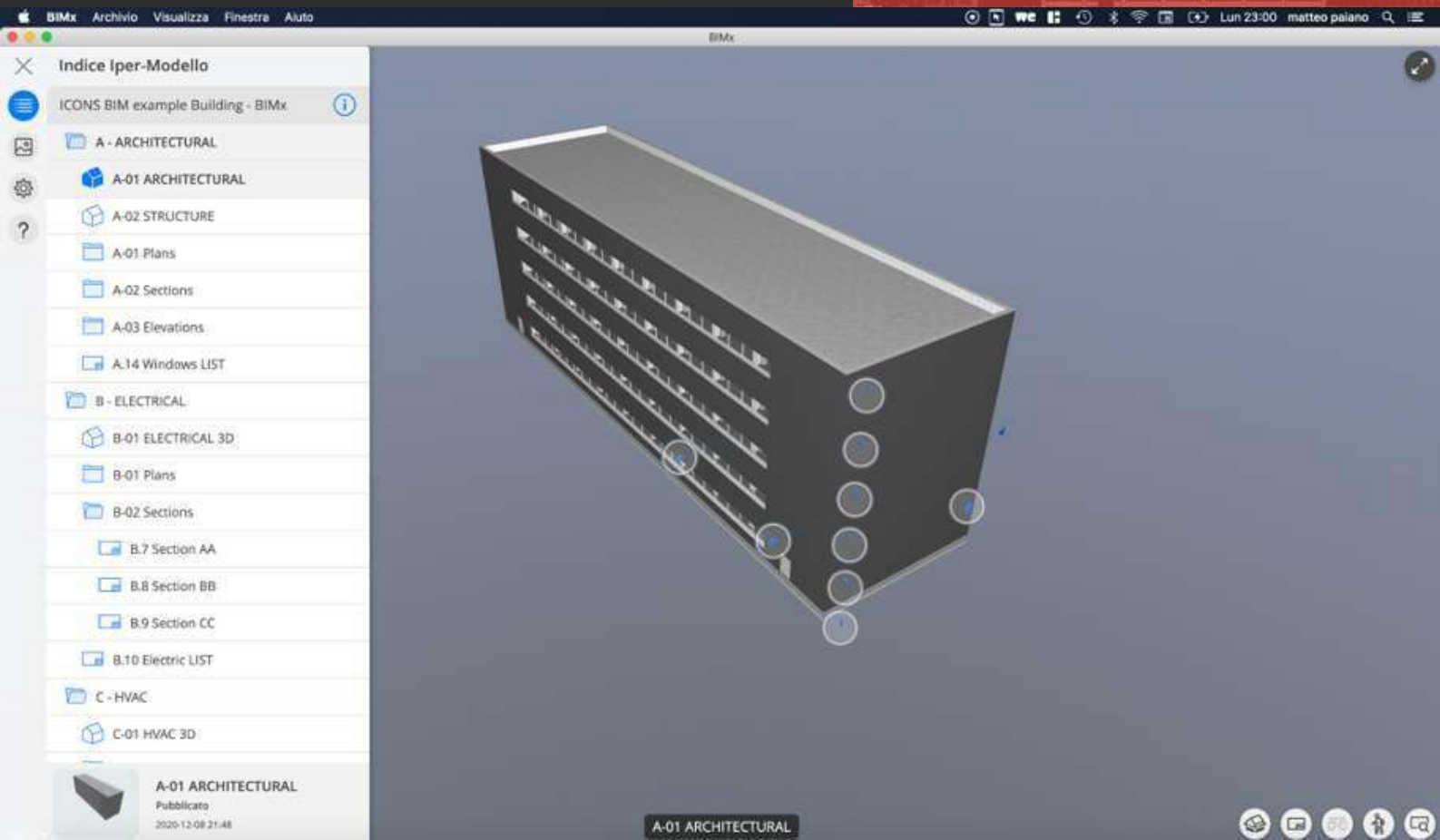
In the first case, the final user will receive a link to download the file from the bimx model transfer web page.

In the second case, the user can press the “plus” button on the top-left corner of the bimx app and then “navigate hyper-model” to look for the downloaded bimx file in your device.

General structure of a file

The structure of the file can be managed by the professional who created it. anyway the professional can organise the file by folder, and in our case scenario the file is structured in folders by discipline (architectural, electrical, plumbing, hvac).

Every folder can contain both 3d views (that may show different aspects of the model) and layouts.



3. VIDEO

How to navigate in the model

The user can navigate in the 3d model by using some gesture:

- 1finger to orbit;
- 2 fingers to pan;
- pinch with 2 fingers to zoom;

It is even possible to navigate in “walkthrough” mode, using a joystick button to move in the 3d model.

It’s even possible to navigate into and through layouts:

- 2fingers to pan and navigate through layouts;
- pinch with 2 fingers to zoom;
- how to create interactive sections

While navigating in the 3d model it is possible to create an interactive cutting-plane with the relative button placed in the bottom-right corner of the 3d view.

It’s even possible to create cutting-planes

3. VIDEO

starting from a plan or section in a layout: here users can find the button to open 3d view, that will be cut with a cutting plane in the place of the section-line.

- **How to take measures**

In bimx it's possible to take measure from the 2d and 3d by using the relative functions, available from the "..." icon on the top-left of the app.
This tool makes it possible to obtain linear, angular and area measures.

How to communicate with professionals

To explain a problem or ask a question about one or more elements in the model, users can use a mix of functionalities:

- first of all they can select the elements from the 3d view by long-pressing on them;
- then it's possible to create hyperlinks related to those elements by tapping on the "selected: n" button on the top-left corner and then on "create hyperlink" in the following menu.

The hyperlink is a special link that will automatically open the bimx model and select the elements related to the hyperlink (if bimx and that exact model are in the device).
Then it's possible to share a screenshot of the model by pressing the "..." button on the top-right corner of the app and selecting the "share" function from the menu.

3.2.2. WORK SPECIFIC MODELS: ARCHITECTURAL

Choose specific views

Once a bimx project is open, it is possible to open one of its folders by using the navigator on the right.

In this case, we will open the "architectural" folder and from the list of contents we will choose the 3d view.

Now from the bottom of the navigator we can tap on the preview to open the 3d window.

- **How to see layouts**

Once the 3d view is open, the user can open the navigator again by tapping on the button on the top-left corner of the app (it recently changed from a "menu" icon to an "arrow" one).

From the navigator it is possible to open folders and inside them the user can find and open both

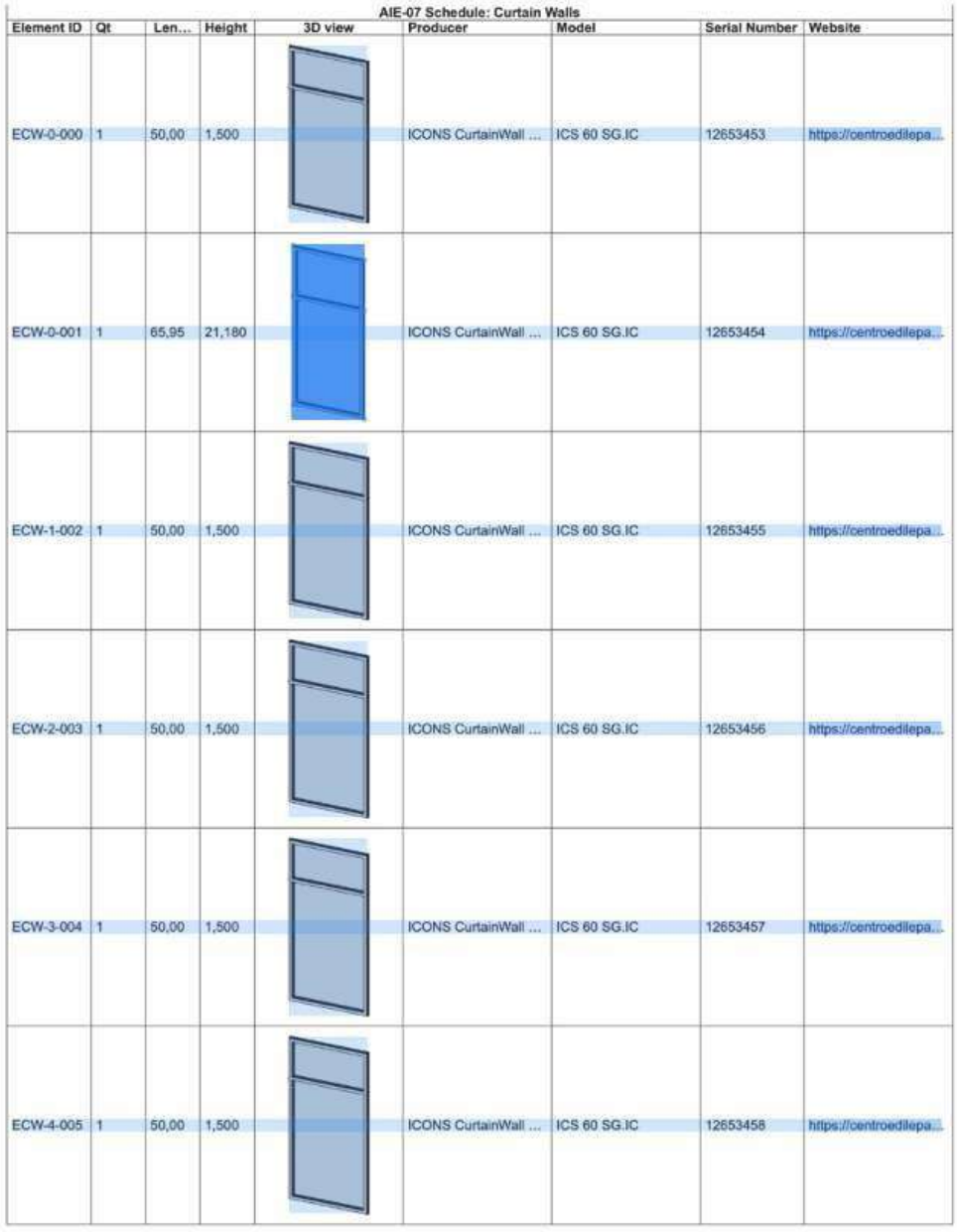
3. VIDEO

3d views and 2d layout.
While the user is navigating in a 3d view, he can even access layouts by tapping on the specific button in the bottom-right corner of the app.

- **How to use schedules**

Schedules are a special kind of spreadsheet-like structured view that can contain various kinds of information and representation about every kind of element in the model.

These views are listed as 2d layouts.
By tapping on an element in the schedule, it's even possible to watch it in 3d.



AIE-07 Schedule: Curtain Walls

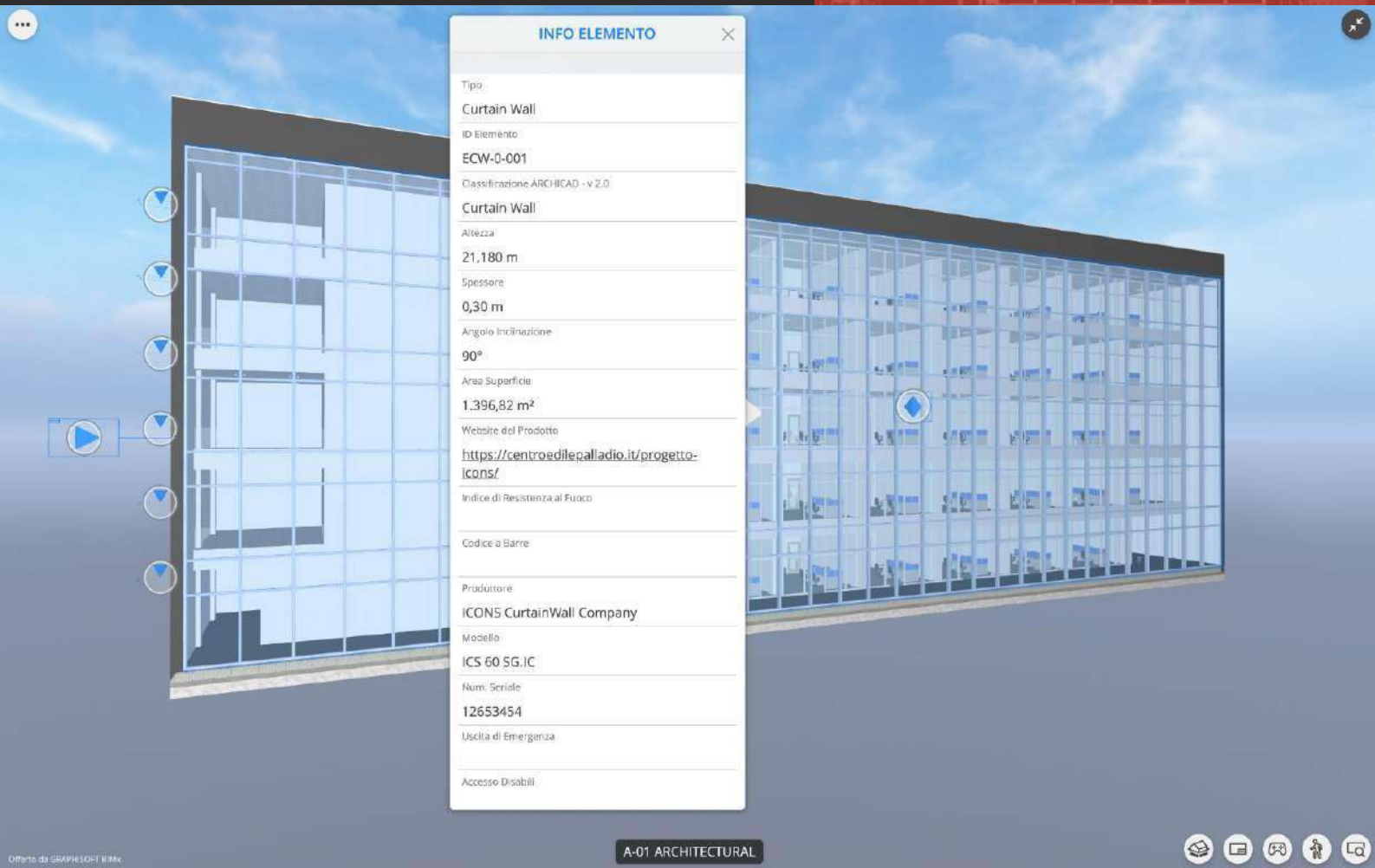
Element ID	Qt	Len...	Height	3D view	Producer	Model	Serial Number	Website
ECW-0-000	1	50,00	1,500		ICONS CurtainWall ...	ICS 60 SG.IC	12653453	https://centroedilepa...
ECW-0-001	1	65,95	21,180		ICONS CurtainWall ...	ICS 60 SG.IC	12653454	https://centroedilepa...
ECW-1-002	1	50,00	1,500		ICONS CurtainWall ...	ICS 60 SG.IC	12653455	https://centroedilepa...
ECW-2-003	1	50,00	1,500		ICONS CurtainWall ...	ICS 60 SG.IC	12653456	https://centroedilepa...
ECW-3-004	1	50,00	1,500		ICONS CurtainWall ...	ICS 60 SG.IC	12653457	https://centroedilepa...
ECW-4-005	1	50,00	1,500		ICONS CurtainWall ...	ICS 60 SG.IC	12653458	https://centroedilepa...

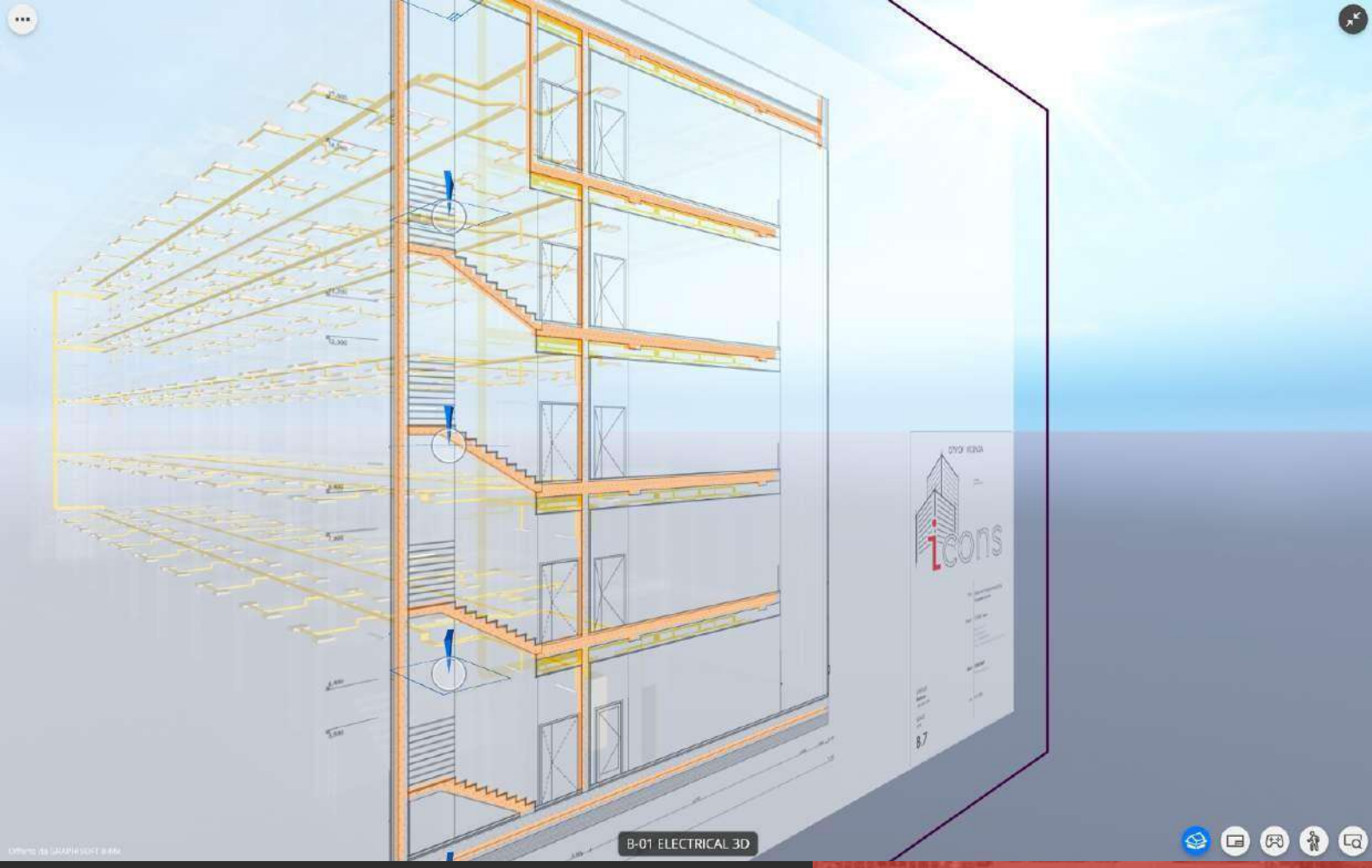
3. VIDEO

How to extract informations from elements

While watching a 3d view, the user can double-tap on every element in the model and, choosing information from the available functions, it's possible to inspect some of the data related to that element.

These elements' information have to be choose and exported from the professional while creating the bimx model.

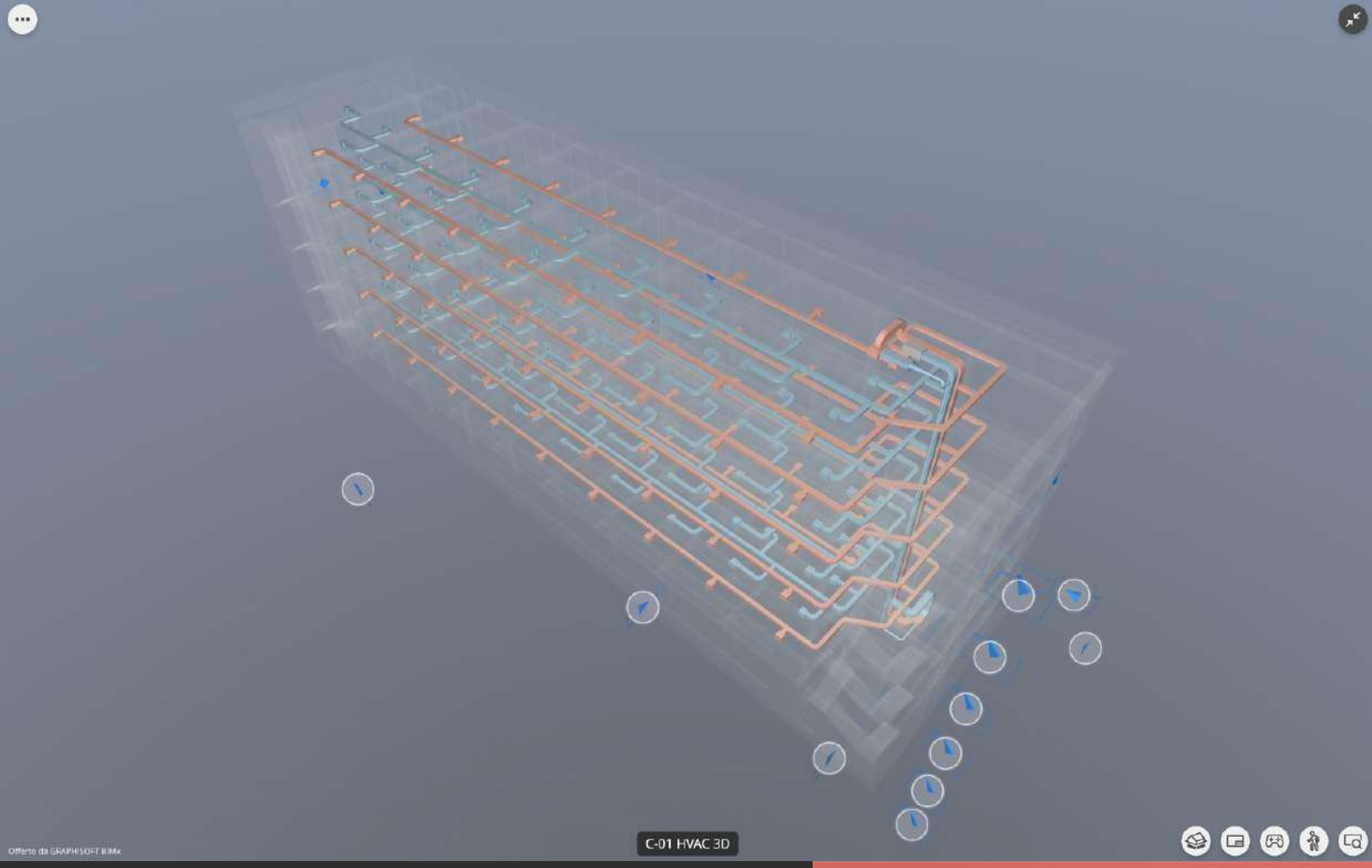




3. VIDEO

3.2.3. WORK SPECIFIC MODELS: ELECTRICAL

- Choose specific views
- How to see layouts
- How to use schedules
- How to extract informations from elements



3. VIDEO

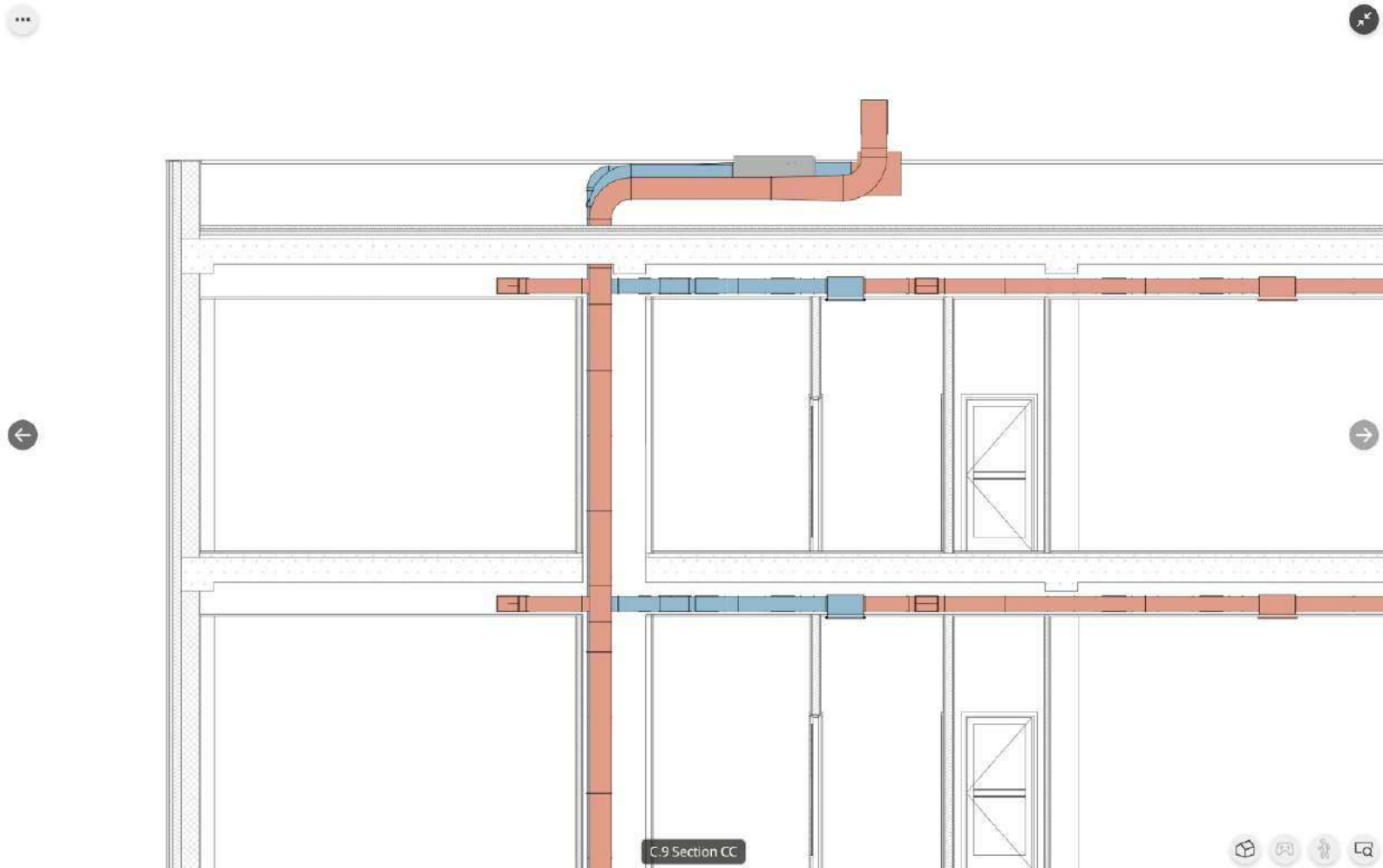
3.2.4 WORK SPECIFIC MODELS: HVAC

- Choose specific views
- How to see layouts
- How to use schedules
- How to extract informations from elements

3. VIDEO

3.2.5 WORK SPECIFIC MODELS: PLUMBING

- Choose specific views
- How to see layouts
- How to use schedules
- How to extract informations from elements



3.3 A360

3.3.1 FIRST STEPS

App download

A360 is available for both android and ios devices. A360 needs a monthly payment, but users can start with a 30 days free trial.

Once the user downloads the app, he can create an autodesk account to start the trial.

Become part of a team

The fastest way to download one or more files in a360 is to be invited in a fusion team.

When a professional invites another user to a team, the new teammate receives an email to go to the project webpage and download all the files related to that project.

To access the project page, the user have to log-in using his autodesk account.

General structure of a file

a360 can open various formats, but the one we are interested in this case is the .rvt file format.

In a360 users can create folders where to place rvt files to organise them the way they prefer.

This work can even be done in a browser, looking for “a360” in the web, logging-in the a360 web page with an autodesk account and creating a project organised the way the customer prefers.

How to navigate in the model

To navigate in a model, the user needs to access

3. VIDEO

it first by opening the folder of the related project and, if the file is structured by discipline, by choosing that specific folder.

Once that the .rvt file is open, the user can open the “sheets” menu by tapping the first icon on the left of the app. The user can navigate in the 3d model by using some gesture:

- 1 finger to orbit;
- 2 fingers to pan;
- Pinch with 2 fingers to zoom;

It is even possible to navigate in “detailed mode” (also known as walkthrough), using a joystick button to move in the 3d model or to use the top-right cube-view to use the main orientations.

It's possible to isolate or hide elements using the “parts” menu (second button on the left) to ease the navigation in the model.

It's even possible to open layouts by using the “sheets” menu and selecting a 2d view.

To navigate in 2d sheets, the user can:

- Swipe with 2 fingers to pan;
- Pinch with 2 fingers to zoom;

How to take measures

In a360 it’s possible to take measures just in 2d sheets.

In the 2d sheets it’s possible to activate the “measure” tool by tapping on the ruler icon on the bottom of the of the app:

3 new buttons will appear on the bottom to give the user the possibility to choose between linear, angular and area measure.

- **Communicate with professionals**

There are different ways to take notes and share them with the rest of the team while using a360.

One method is to activate the “markup” tool by tapping on the pencil icon on the bottom of the app to be able to draw lines, arrows, texts etc. comments can even be created by double-tapping on an element from the 3d view.
Once that the note is ready, the user can press the share button on the top-right corner of the app to save in the comments.
All the notes are available from the “comments” menu that can be opened by tapping on the third icon on the left of the app.
The comments will be automatically shared with the rest of the team (if you are part of), otherwise it’s possible to share the whole file and its comments:
The user just needs to quit the project and tap on the “i” icon under the preview of the project and choose from the “share” function from the menu.

3.3.2 WORK SPECIFIC MODELS: ARCHITECTURAL

Choose specific views

If the project’s folders are structured by discipline, the user can access the architectural model by opening the relative folder and tapping on the architectural model preview.
Once that the project is open, users can navigate using the functionalities previously described, such as gesture, the view-cube and the walkthrough functions.

Open drawings

Once that the project is open, the user can

watch a 2d layout using the “sheets” menu that appears tapping on the first icon on the left of the app:
From the drop-down menu the users can select the 2d view he is interest in to open it.
As we saw in the intro, it is possible to navigate in the 2d using the previously described gestures.

How to extract informations from elements
While in the 3d view it is possible to read info about an element by double-tapping on it and selecting the “i” icon: this will open the “properties” menu, that contains all the information about the selected element.
Users can even access the information of an element by selecting it from the “parts” menu (the second icon on the right of the app) and tapping the button on the right of the listed element to activate the “properties” function from the contextual drop-down menu.

3.3.3 WORK SPECIFIC MODELS: ELECTRICAL

- **Choose specific views**
- **How to see layouts**
- **How to extract informations from elements**

3. VIDEO

3.3.4 WORK SPECIFIC MODELS: HVAC

- Choose specific views
- How to see layouts
- How to extract informations from elements

3.3.5. WORK SPECIFIC MODELS: PLUMBING

- Choose specific views
- How to see layouts
- How to extract informations from elements

4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.1 INTRODUCTION

The icons App is a **multiplatform multimedia application** that allows users to review all the material generated in the BIM-oriented training courses in an interactive way. So the user can review the course using mobile devices (tablets, smartphones, etc.) working with the IOS operating system of Android.

For the development of the application a real time development platform has been used that allow to keep the multiplatform feature indicated and integrate the different multimedia elements included in ICONS app: 3D graphics, Augmented Reality, Video, Images, hyperlinks and text.

The selected development platform has been Unity 3D in his version 2019.4, also the Vuforia Augmented Reality library has been added.

4.2 APP DESIGN

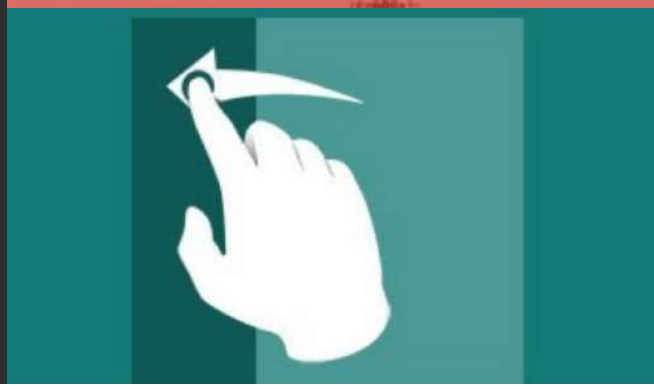
To make the app easy to understand and to use for the design of the interaction a well-known interaction metaphor has been used. The metaphor is based on the idea of a slide carousel. The carrousel has embedded in each one of its slides the different structured contents. So, in each slide the user will be able to find different contents supported by the proper media: text, images, videos or even 3D

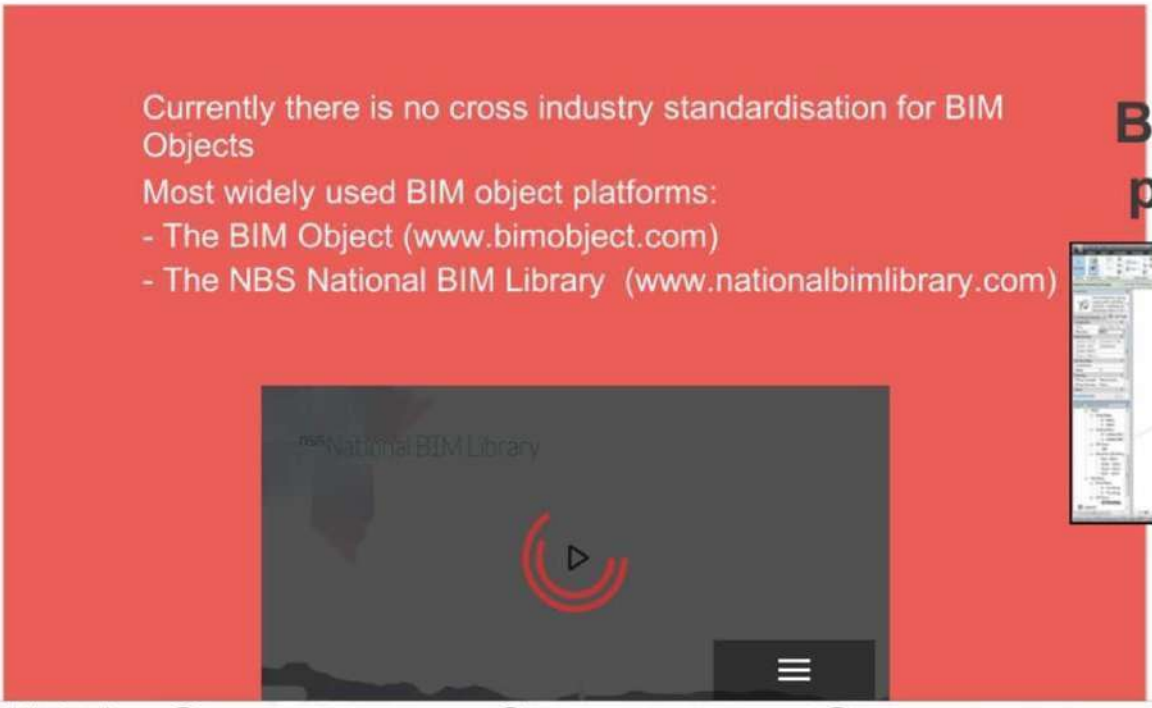
4. APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

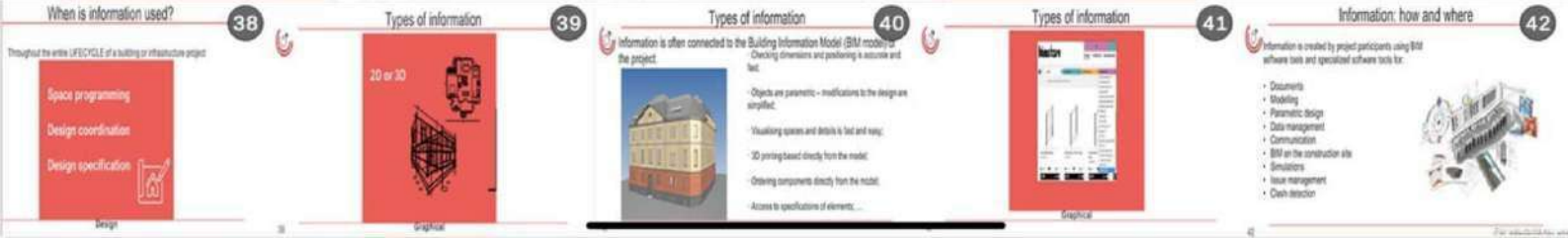
interactive graphics.

The interaction with the system is in this case based on using the touch interaction to swipe between one slide and the following.

To make navigation easier and faster two indexes have been added, one at the initial slides to jump directly to each one of the content modules and an additional miniature index that allows to locate in a visual way the desired content and tap to go to it in the miniature. See following images.







4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3 TYPES OF CONTENTS AND INTERACTION

As previously indicated the type of contents are based on different media and interaction with the media to explore the information. In this section we will be detailing the different types of contents and interaction supported in the Icons app.

The app is structured in three main parts: Theoretical contents, BIM Visualization Tools and Final Test Evaluation.

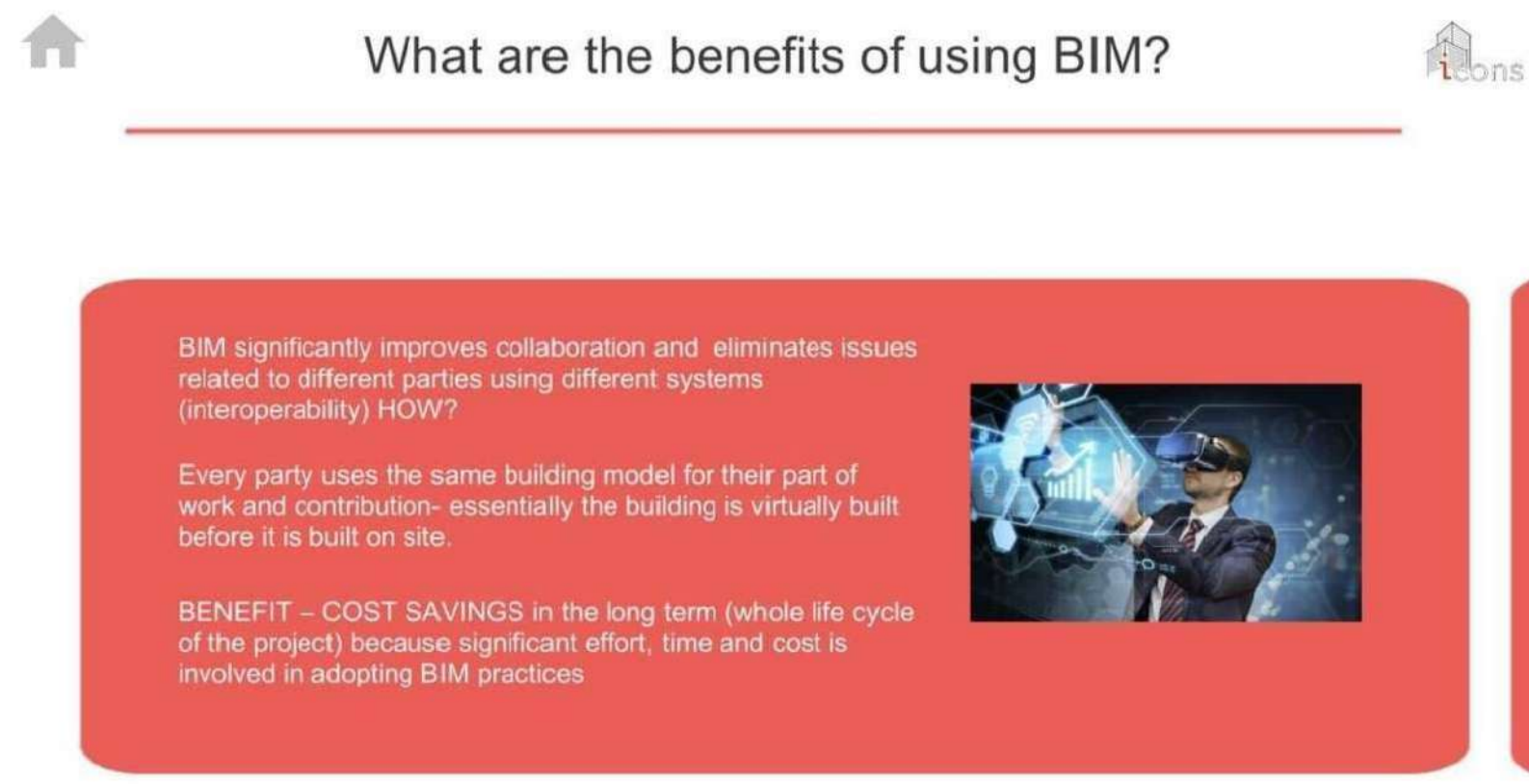
In the previous index image, it is possible to see that there are nine main theoretical modules. We can navigate to the beginning of each module tapping on the index or by using the miniature index. Inside these modules we can find the following type of contents.

4. APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3.1 TEXT AND IMAGES

This is basic non-interactive contents that the user can read and watch to extract the info. You can see below a sample image.

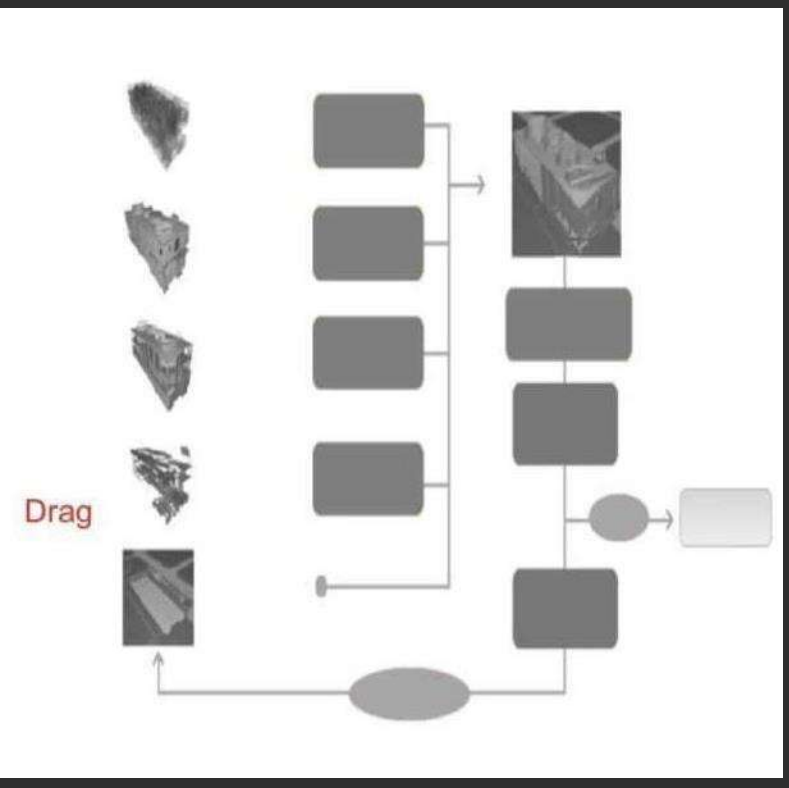
When an image appears always a link to the original source is offered to extend the information see the down part of the previous image. This links is open in an external navigator depending on the configuration of the device used to explore the app.

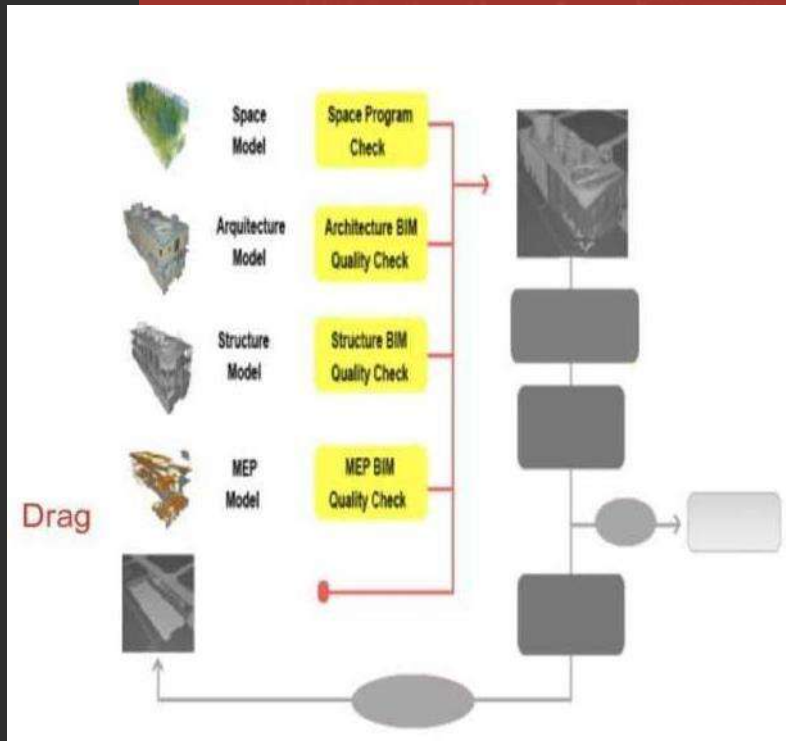


4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3.2 INTERACTIVE IMAGES

To condense information in less slides and make the app more engaging, some of the contents have been organized using interactive images. When this happens an icon like the one appearing in the following images is displayed to indicate to the user that this is an interactive content. The type of interaction could be tapping parts of the image, dragging, swiping, etc., this depends on the specific type of information to be displayed. Proper indications are given to allow the adequate interaction.



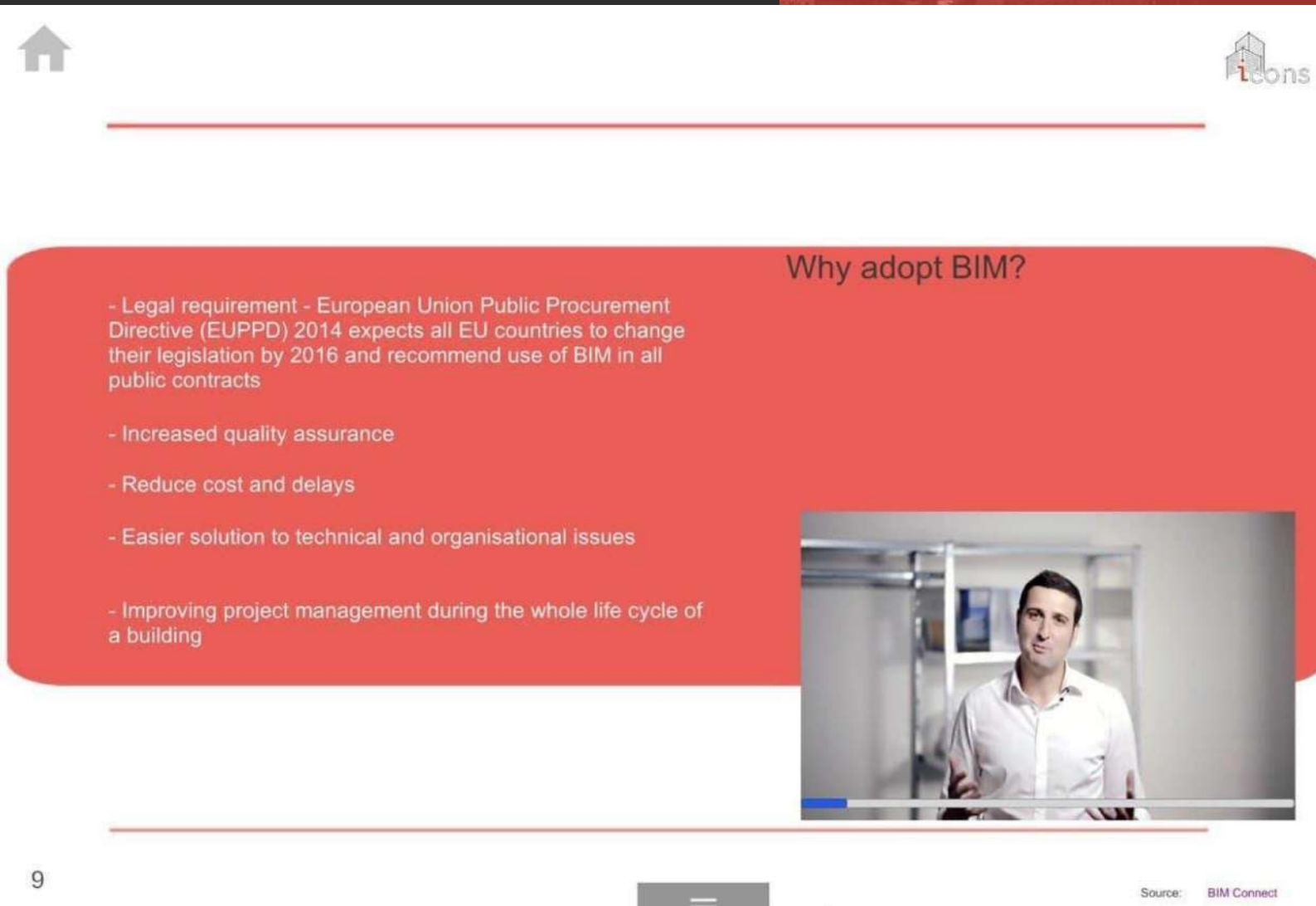


4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3.3 VIDEOS

Another important type of content is related to videos. The videos are embedded in the slides and have an icon to identify them. See the image below.

To play the video just touch the icon the video starts to play. There is a time bar that allows you to jump to different points of the video. The video can be zoomed to see better the details by using the usual zooming two finger touch. Also the source of the videos is linked to the source origin to allow extended information.



4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3.4 EMBEDDED 3D CONTENTS

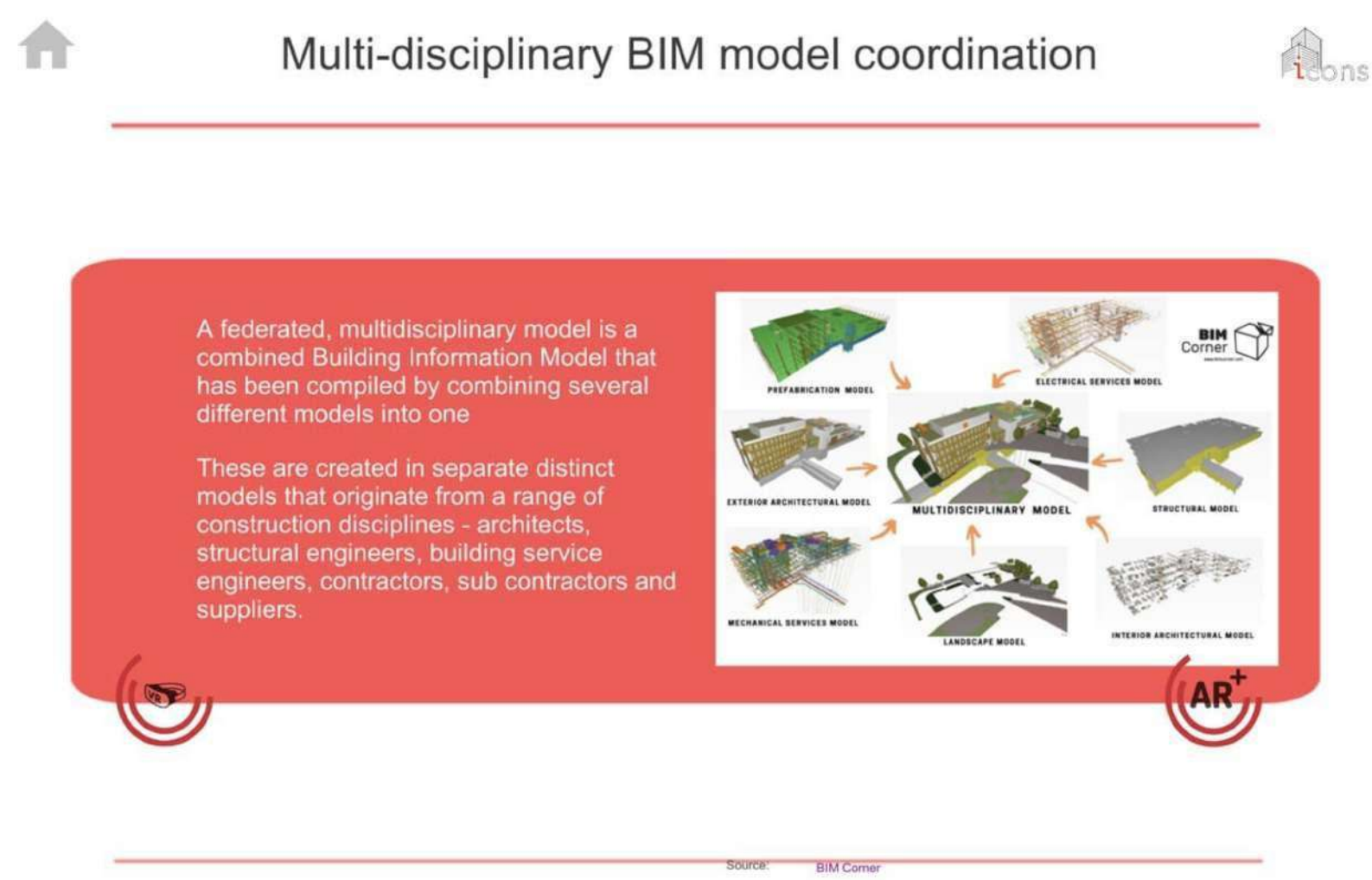
Some of the pages include 3D elements that we can manipulate (rotate) inside the slide

4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3.5 VIRTUAL REALITY CONTENTS

The app includes a part of 3D interactive contents that allow users to navigate interactively a 3D building to understand in a spatial way the type of information offered by BIM tools.

There is an icon that allows you to display this sample building. See picture below.



4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

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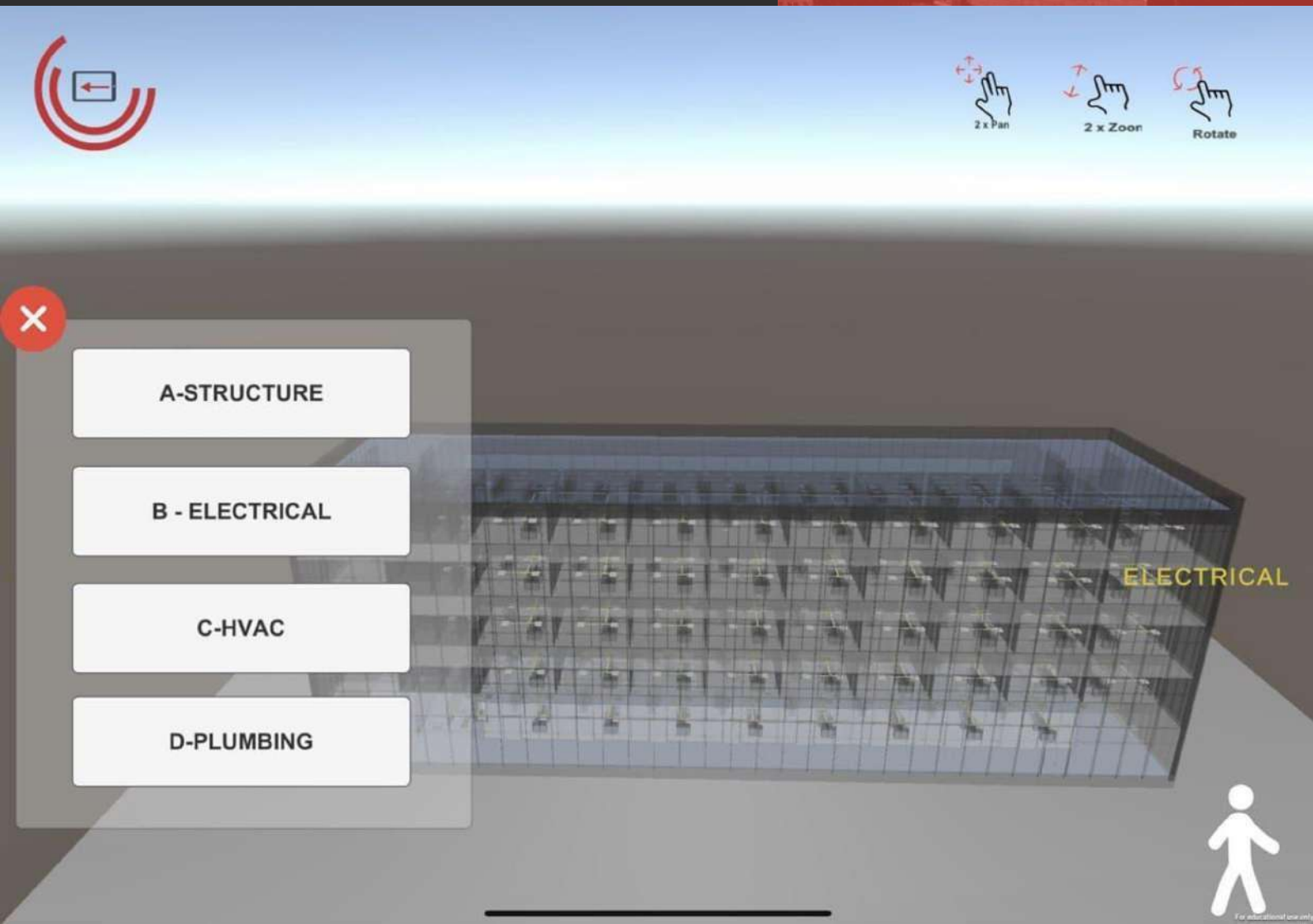

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The user can also walk inside the building to see the details and navigate inside using different view configurations (X-ray, filled). See some sample images below.

4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3.6 AUGMENTED REALITY CONTENTS

The app also allows users to explore the BIM information associated with a building using Augmented Reality interaction. To access this part, the AR icons that appear in the page that we have previously shown for VR is used. To be able to use the AR the user needs to have a printed page with the icon of the Icons project. See the images below.

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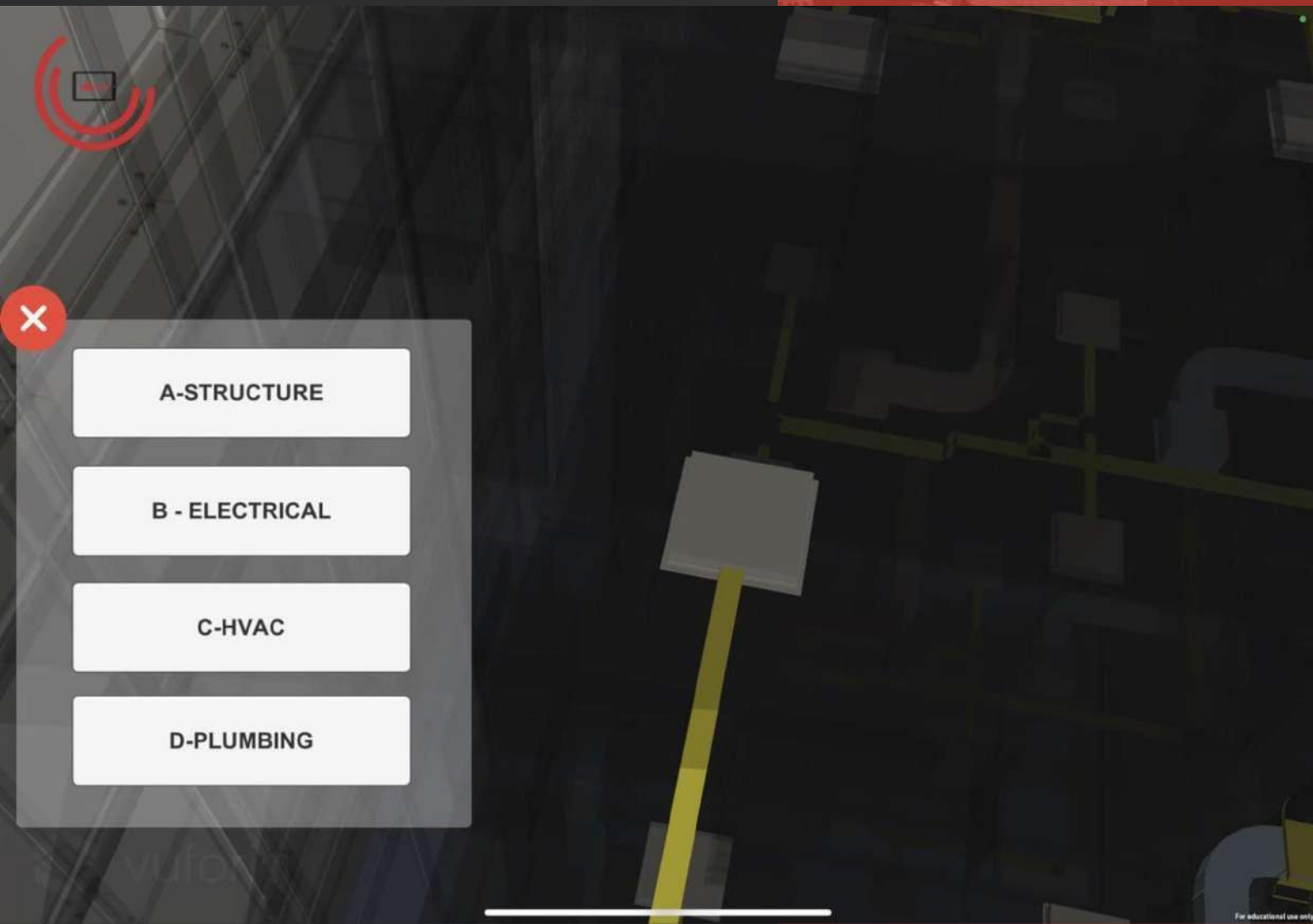
When the system detects this mark it shows a floating virtual mockup of a building. The user can observe the details of the building and the different BIM information just walking around with the mobile device pointing at the mark.

If the user move close enough to the mark he can even explore interior details of the building.

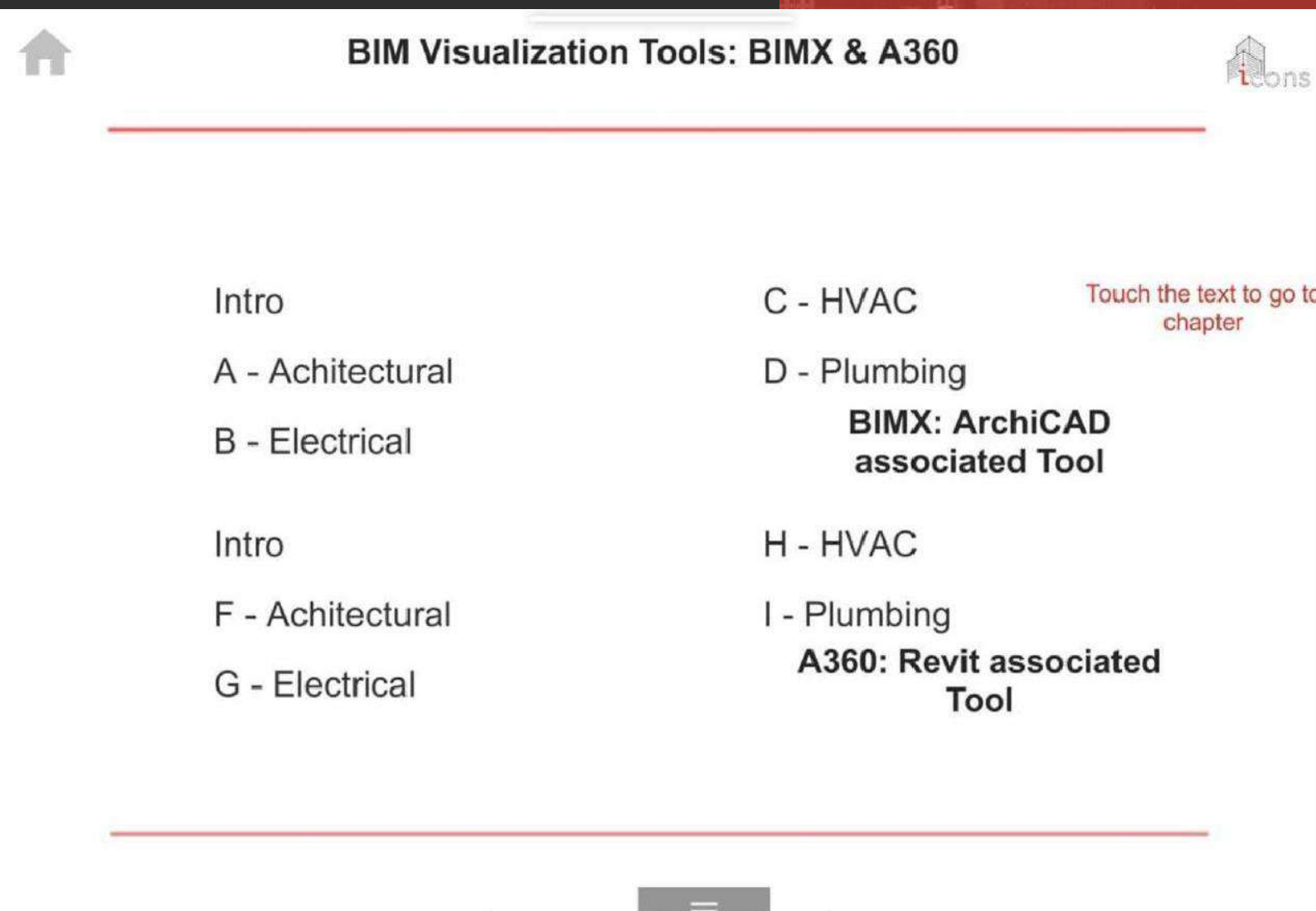


4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.3.7 VIDEO CARROUSEL

Previously it has been indicated that one of the contents for the app was a section with the way to use two of the most common tools for exploring BIM information in mobile devices: BIMX and A360. To access this information we have prepared a specific index.

In this index we have four sections, five sections for each one of the tools that allow us to learn the basic usage of each one of them. The contents have been created in the form of tutorial videos. These videos have been structured in video carrousels to make them more accessible to the user. In the following images a sample of the video carousels is shown.



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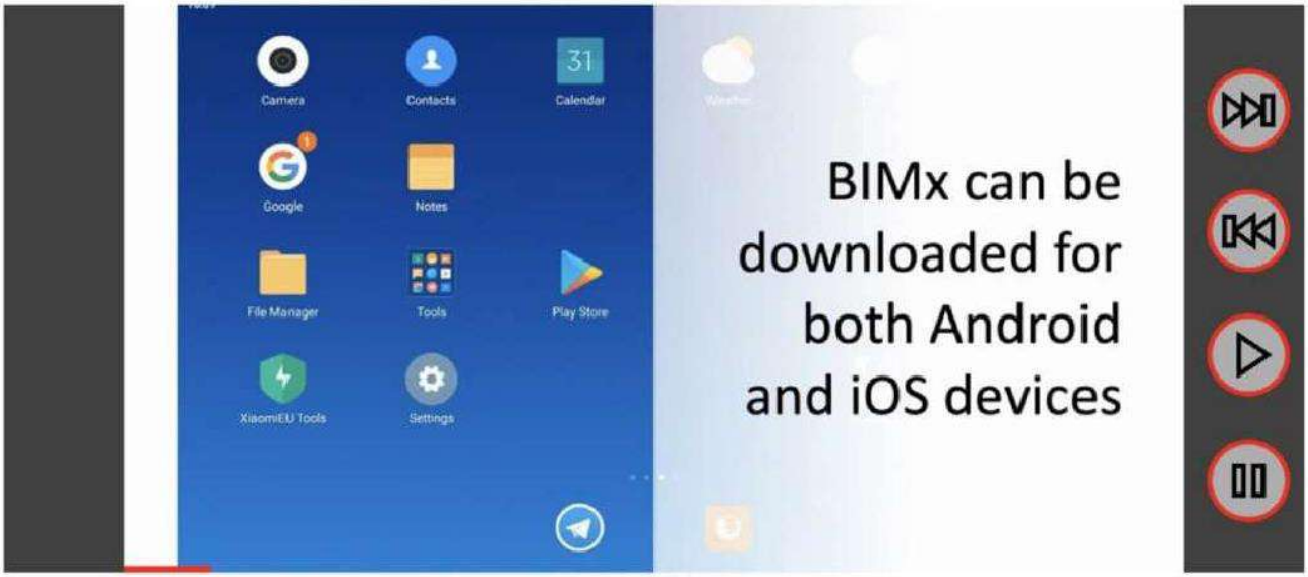
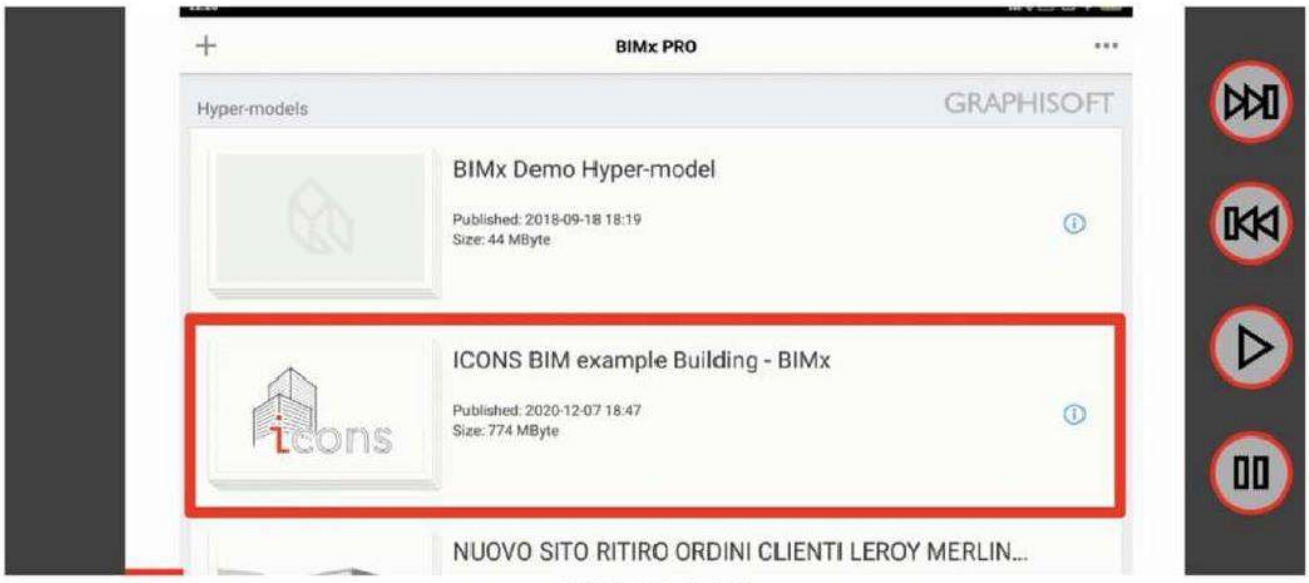
Each video carousel has a different number of videos depending on the content. The number of videos and the current video is indicated by a collection of dots in the low part of the carrousel. The user can change video just by swiping on top of the carousel. On the left part of the carousel a video control panel allows the player to control the play of the current video.



Download BIMx

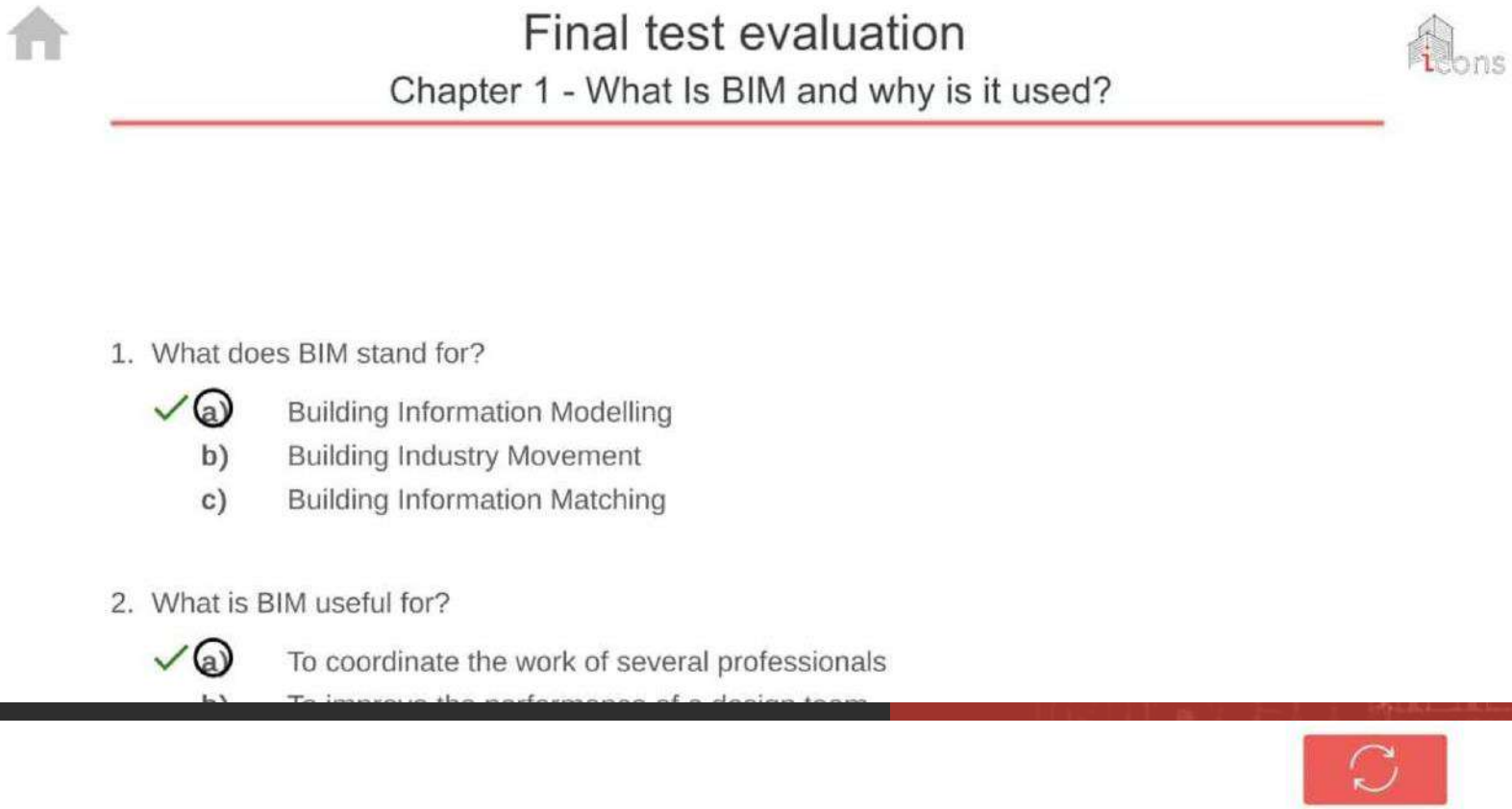


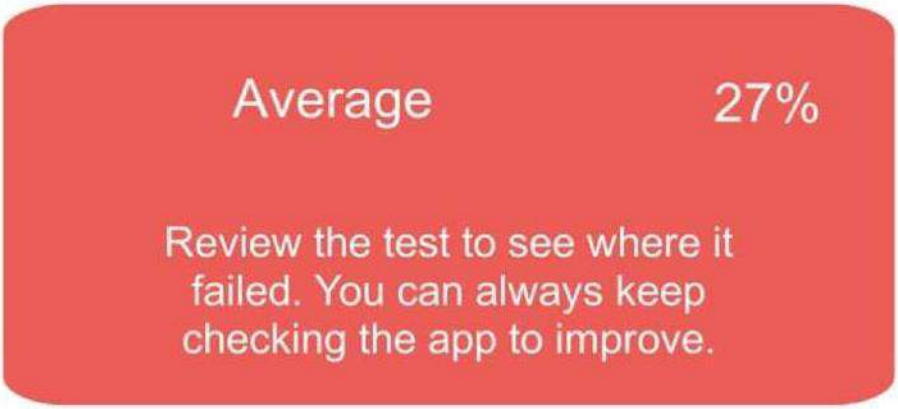
Navigate the 3D Model

4.APP FOR WORKERS 4.0 IN THE CONSTRUCTION FIELD

4.4 EVALUATION TEST

Finally, the app allows to do, and evaluation test of the knowledge acquired using the system. The test is placed at the end and the user can interactable answer the test. In the last page he can validate the answer and the system gives the score and feedback with the questions with right and wrong answers. See the images below.





5.CONCLUSION

The process of digitalization is rapidly changing the way professionals of the AEC sector use to work and we may expect that even the building site workflow will be involved in this change little by little.

In the whole EU these new methodologies will become mandatory in a few years for all the works related to public buildings, and even big private investors that have many buildings in their investment portfolio will probably follow it once that will be clear the advantages related to data driven analysis and management.

The galaxy of software related to the BIM process and to the construction phase is quickly growing, so we can expect that lots of changes may arrive in the future.

Anyway the path of this training is a good starting point to make worker aware of what they will probably start to see on the building site in a few years:

Constantly updated data provided by applications will reduce wasted time thanks to a direct connection with the professionals' offices, avoiding all the errors that a federated 3D model can prevent.

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INNOVATION IN CONSTRUNCTION SITES

Co-funded by the Erasmus+ Programme of the European Union

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