



Scan to BIM for Retrofitting Historical Buildings

Milan's Teatro Lirico Opera House Renovation

Ilaria Lagazio

BIM Senior Technical Specialist – Autodesk Italy

Davide Rigoldi

Named Account Sales Executive – Autodesk Italy



Class summary

In this session we will present the activity developed in Milano for renovation of an ancient building using the BIM technology.

This experience will show how to push BIM to face the highest level of complexity in order to organize a renovation activity

Key learning objectives

At the end of this class, you will be able to:

- Describe Autodesk workflow for renovation
- Understand the kind of context the technology can be used in order to give new life to traditional industry
- Learn the value of BIM for Historical Heritage
- Understand the huge BIM opportunity for the renovation market in traditional markets
- Understand the opportunity of BIM for Government



Historical Background



What is Teatro Lirico

The former “Teatro Regio Ducale” had been destroyed by a fire in 1776.

Several years after, the Archduke Ferdinand, son of Maria Theresa of Austria, proposed to provide the city of Milan of two opera houses

- The Noble Theatre: to be erected near the court on area of the “church of Santa Maria alla Scala” known today as “La Scala”
- The Popular Theatre: to be built on the area of Schools Cannobiane



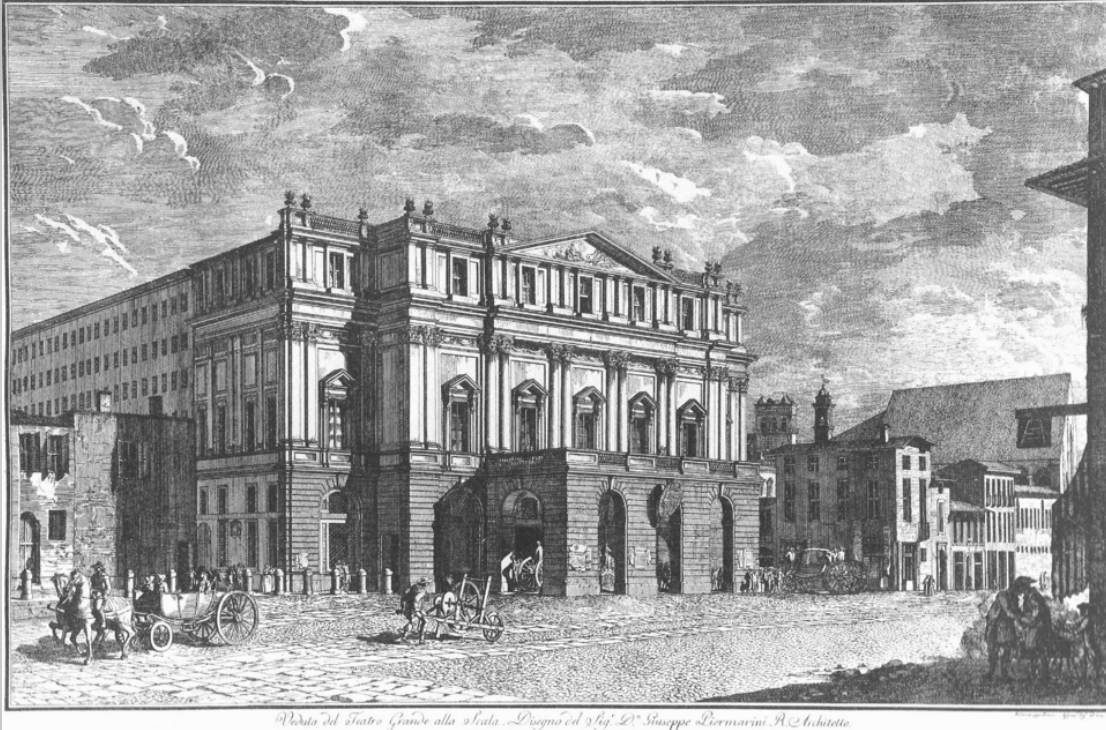
*Archduke Ferdinand
Habsburg dynasty
1863-1914*

What is Teatro Lirico

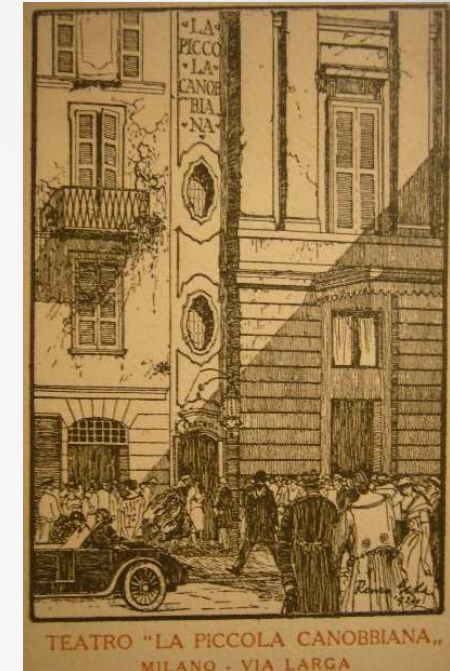


Both projects, similar in plant and sections following the “Italian traditional style” are developed by the “*Royal architect Giuseppe Piermarini*”.

Old «Renderings»....



La Scala – copper serigraphy

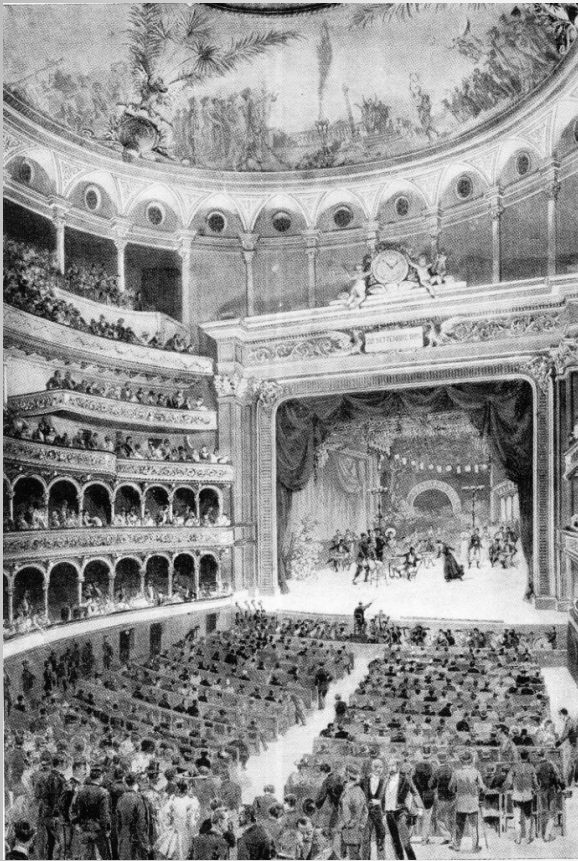


La Cannobbiana - postcard

“ La Cannobbiana” was inaugurated one year later “La Scala” on the evening of 21st August 1779



1894 – Teatro Lirico Internazionale



With the reduction of subsidies for municipal and prohibition of meeting in public places, the Cannobiana begins a situation of decline in 1870's .

The musical editor Edoardo Sonzogno takes the decision to renew it and make an important center of culture under the name of “Teatro Lirico Internazionale” (International Opera House)

A postcard of 1902



The inauguration, dated 1894



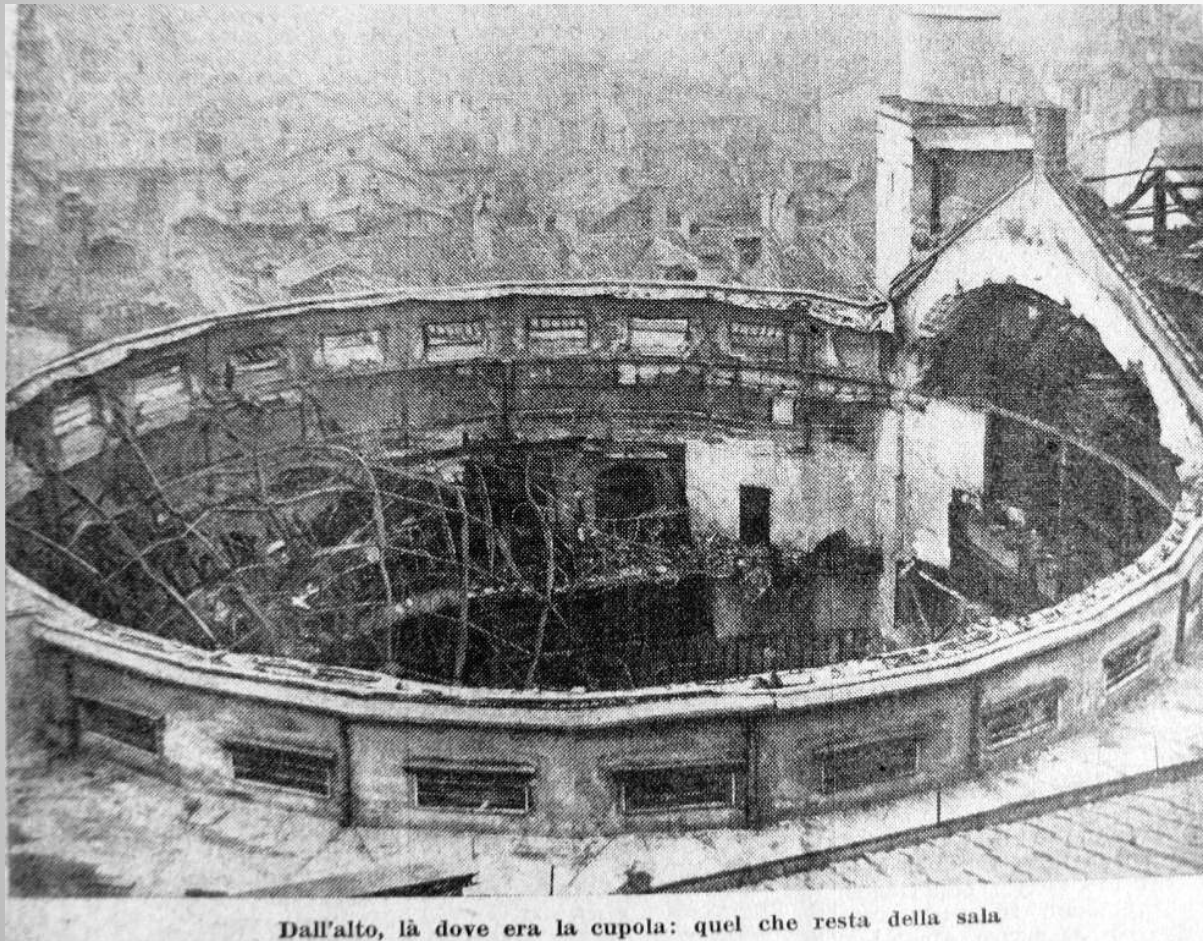
1938 – The Teatro Lirico destroyed by fire



A newspaper dated
9 february 1938



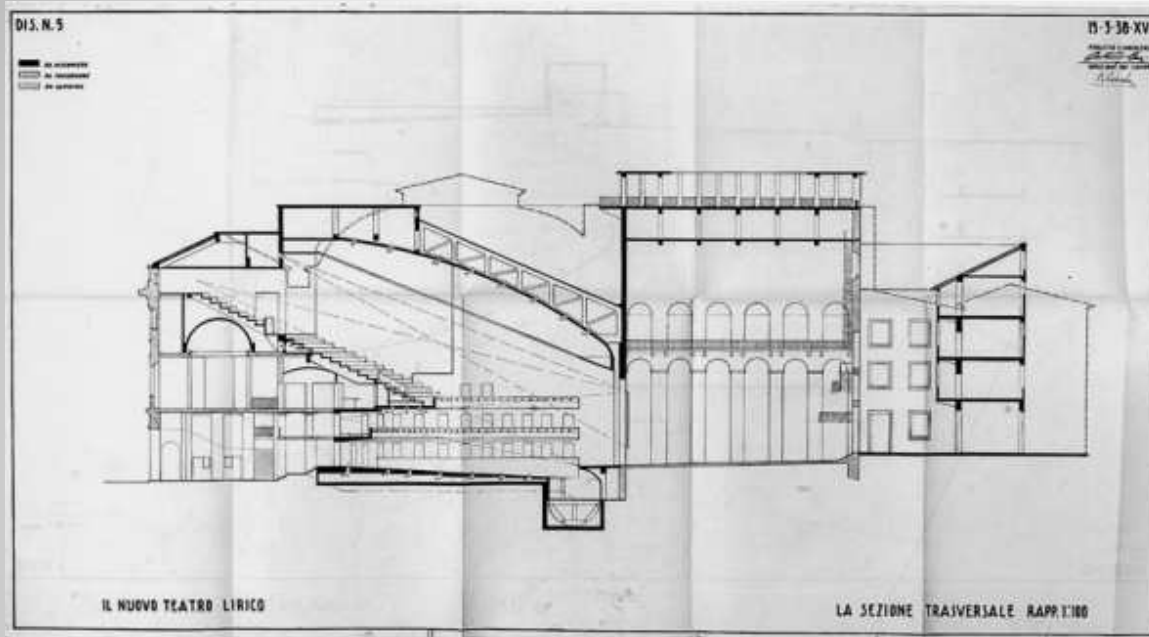
1938 – The Teatro Lirico destroyed by fire



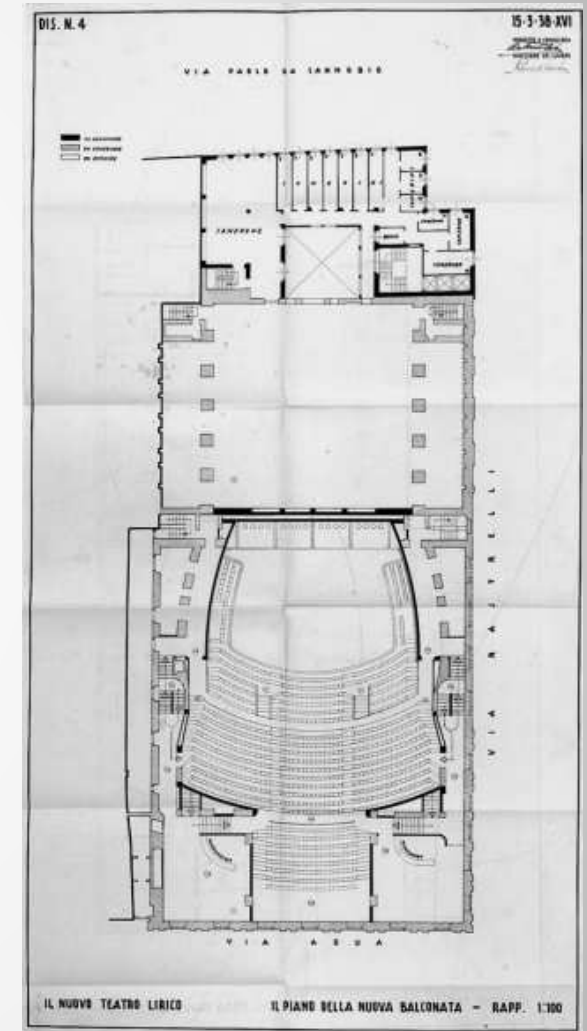
After this tragical event, the city decided to rebuild the opera house in a new shape: the project is commissioned to *Architect Antonio Cassi Ramelli*



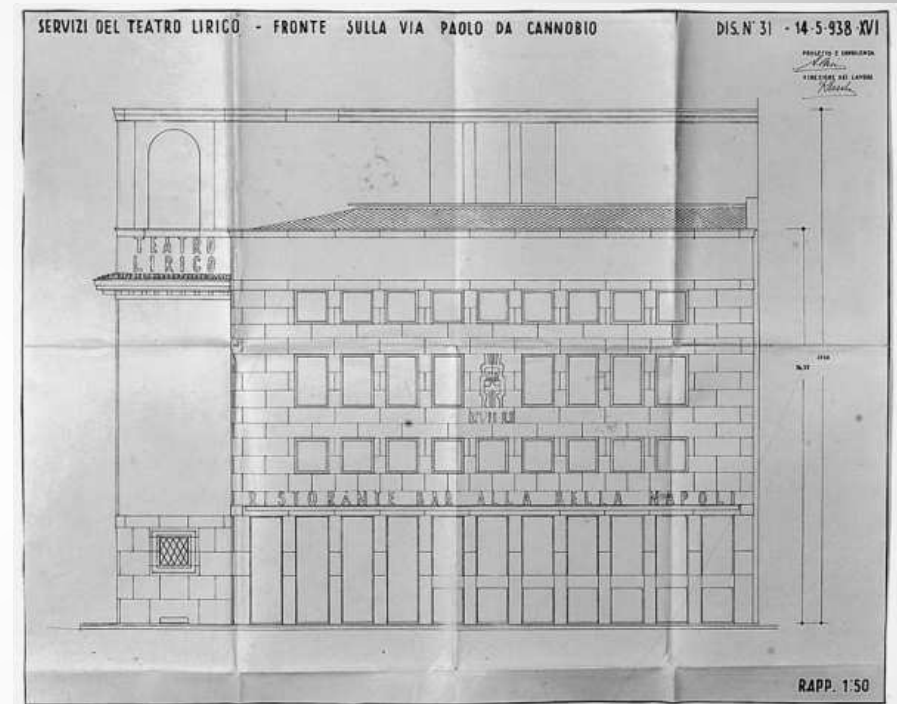
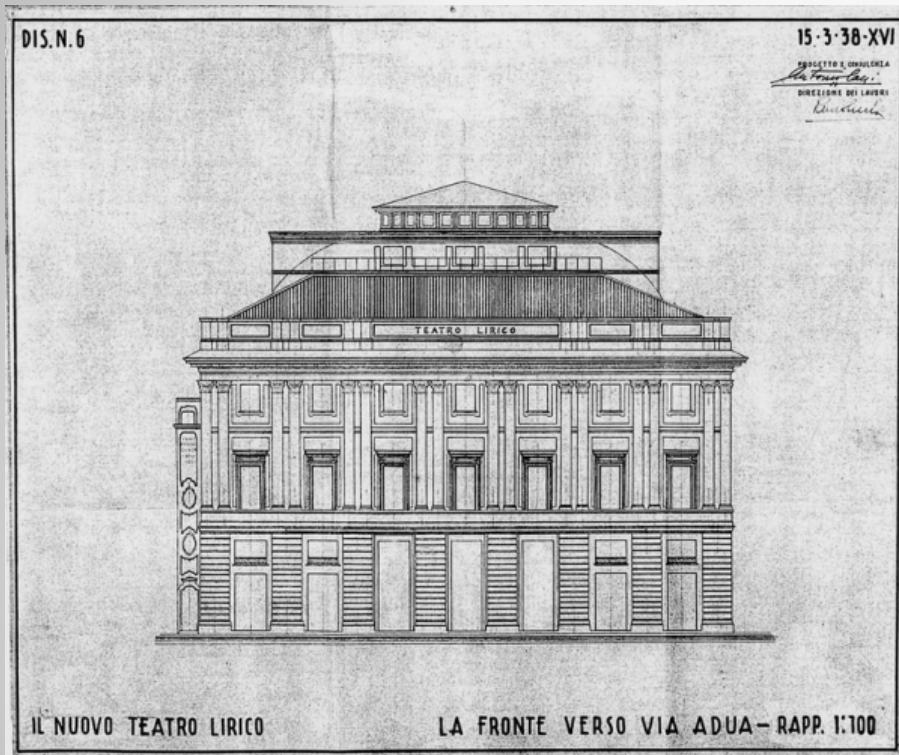
Cassi Ramelli Project – The «New Teatro Lirico»



We are in full Fascist Period. The original shape and some peculiar historical details were sacrificed in favor of more seats, in order to reach most people as possible during the historical speeches of the leader.



Cassi Ramelli Project – The «New Teatro Lirico»



These are the newest drafts we had related to the actual shape

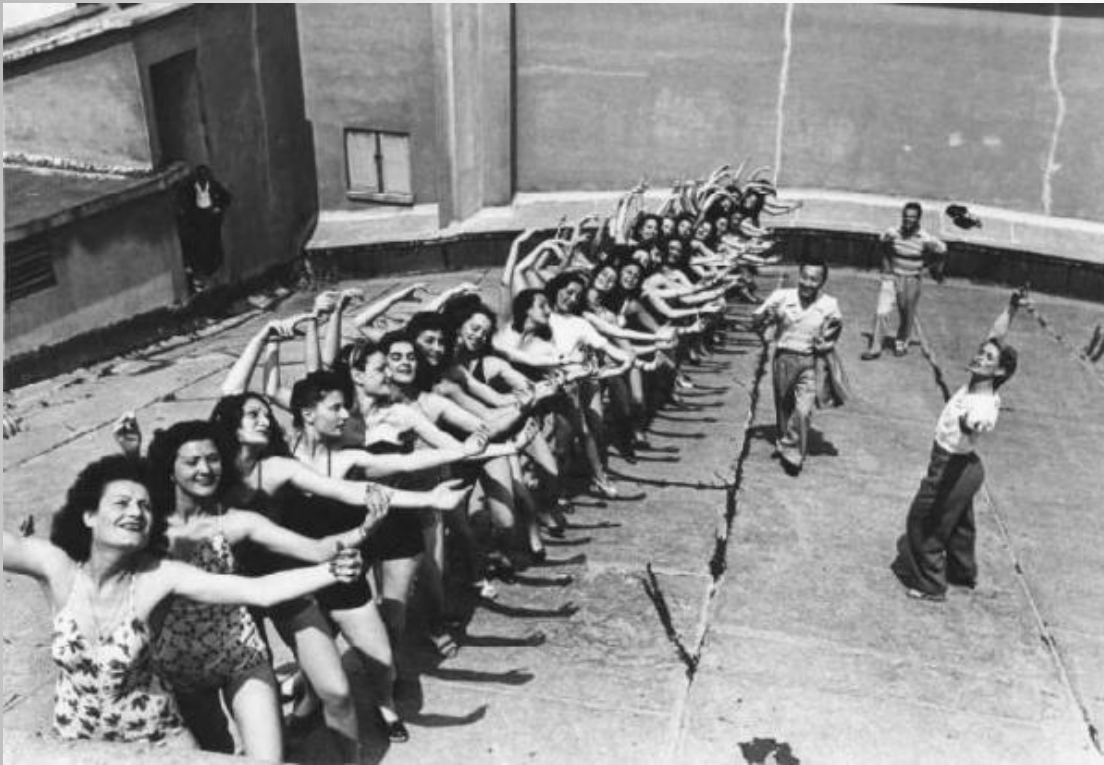
1939 – The New Teatro Lirico



Architect Cassi Ramelli gives a new life to the building giving it the modern shape it has today. It opens again in 1939, inauguration 11 May.



Exercising on the roof – July 1946



2009 – Renovation Activity



In 2009 starts an activity of renovation but because of multiple problems the Municipality revoked the mandate.

This is how the building appears today



2009 – Renovation Activity



In 2009 starts an activity of renovation but because of problems related to the Contractor bankrupt the Municipality revoked the mandate.

This is how the building has been given back to the Municipality

The Project



Workgroup

- Autodesk Consulting
 - Matteo Giani, *BIM Manager*
- Comune di Milano Technical Office
 - Pasquale Mariani Orlandi, *Architectural Supervision*
 - Vittorio Angeleri, *Project Coordinator*
 - Mario Benedetto, *IT Manager*
 - Gemma Pinto, *BIM Modeler and Model Coordinator*
 - Alessandro Savarese, *BIM Modeler*
 - Maria Botti, *BIM Modeler*
 - Patrizia Lombardo, *BIM Modeler*
- Leica Geosystems
 - Alessandro Grieco and Simone Oppici, *Laser scanning and registration*
- Milan's Politecnico University
 - *Acoustic tests*
- Metropolitana Milanese
 - *Structural analysis*



The situation

- BIM is not mandatory in Government Projects in Italy
- Comune di Milano Technical Office had never applied BIM technology before
- Starting BIM on a project of this complexity and visibility highlighted a complete trust in BIM and in our vision from the Customer point of view

Software involved in the project

- Autodesk Building Design Suite 2014 / 2015
 - Autocad
 - Revit
 - Recap
 - Navisworks
 - 3D Studio Max
- Leica Geosystems
 - Cyclone

Project Data

Total surface	mq. 9380
Seats	1500
Total cost of the project	€ 16.510.000,00

Laser scanner	7 days 550 scan 6.5 billion points *
---------------	--

Registration	1 week
--------------	--------

(*) scan precision less than 1 mm

The Workflow

Laser Scanning and Point Clouds preparation



Laser scanner Leica P20
Leica Geosystems Italia



Clouds
import and
registration

Cyclone software
Leica Geosystems Italia



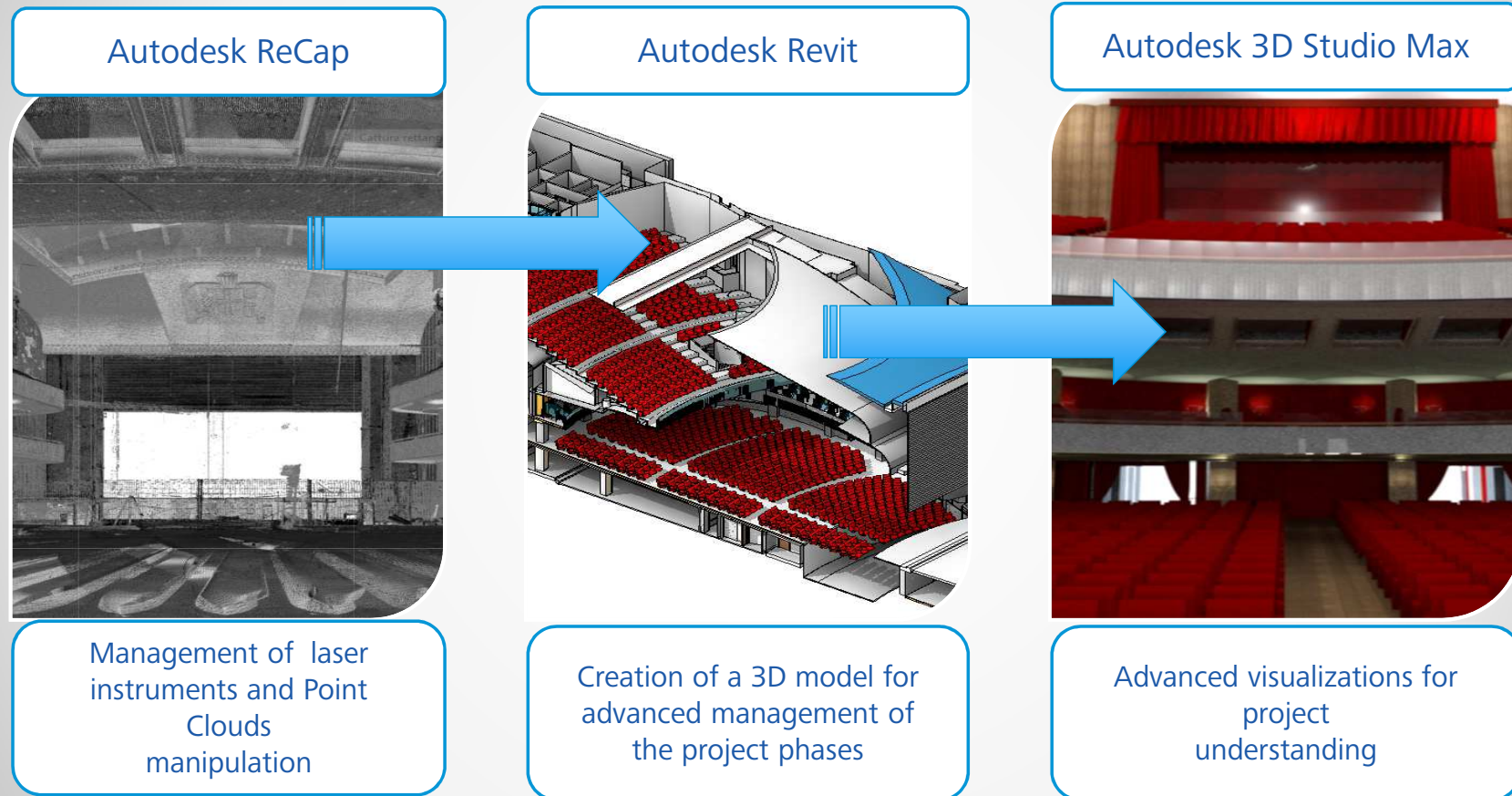
PTG
format

Ready for import in
Autodesk Recap

NB: registration tolerance is up to 3 mm



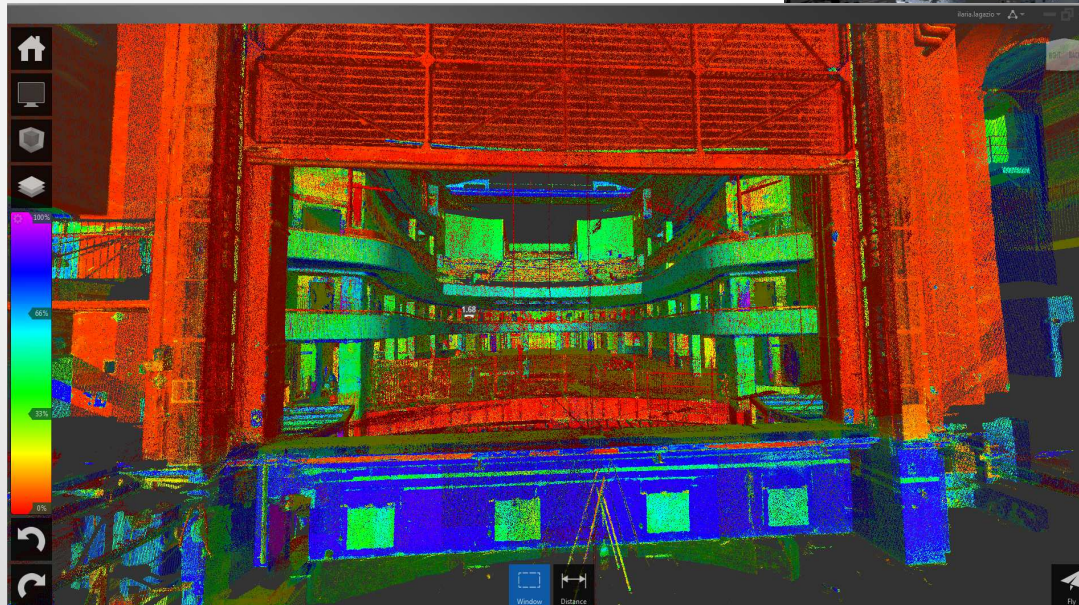
Workflow



Autodesk ReCap and Point Clouds

Through laser scan and point clouds we can get a precision impossible to achieve using the classical method.

Thanks to the very high number of points we got a graphical remarkable precision.

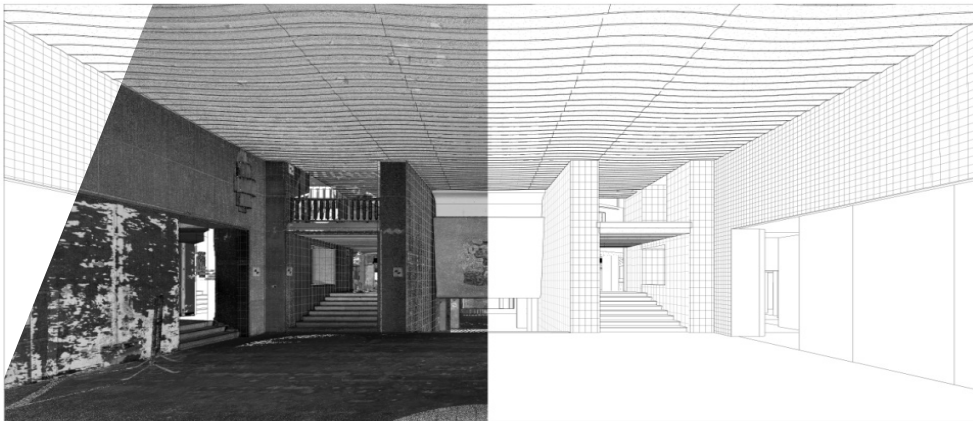
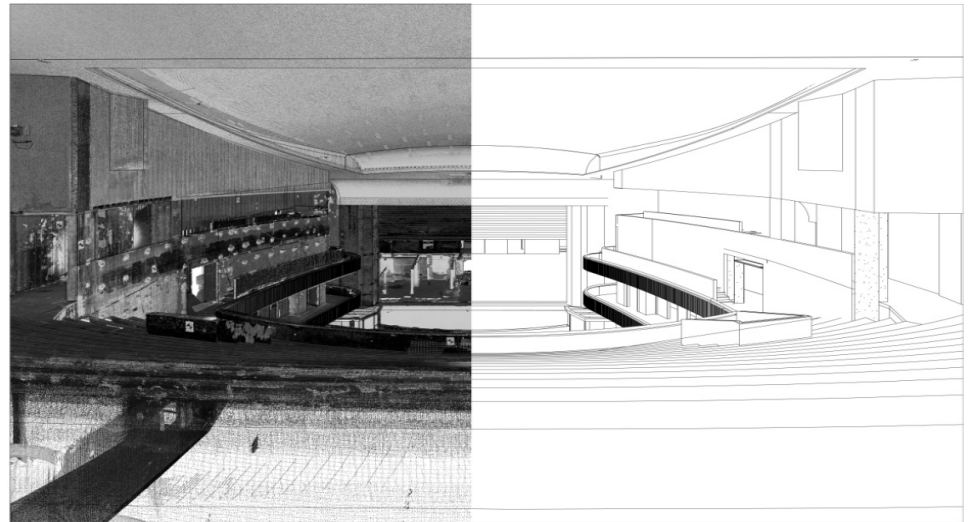




From the Points Cloud to the Model



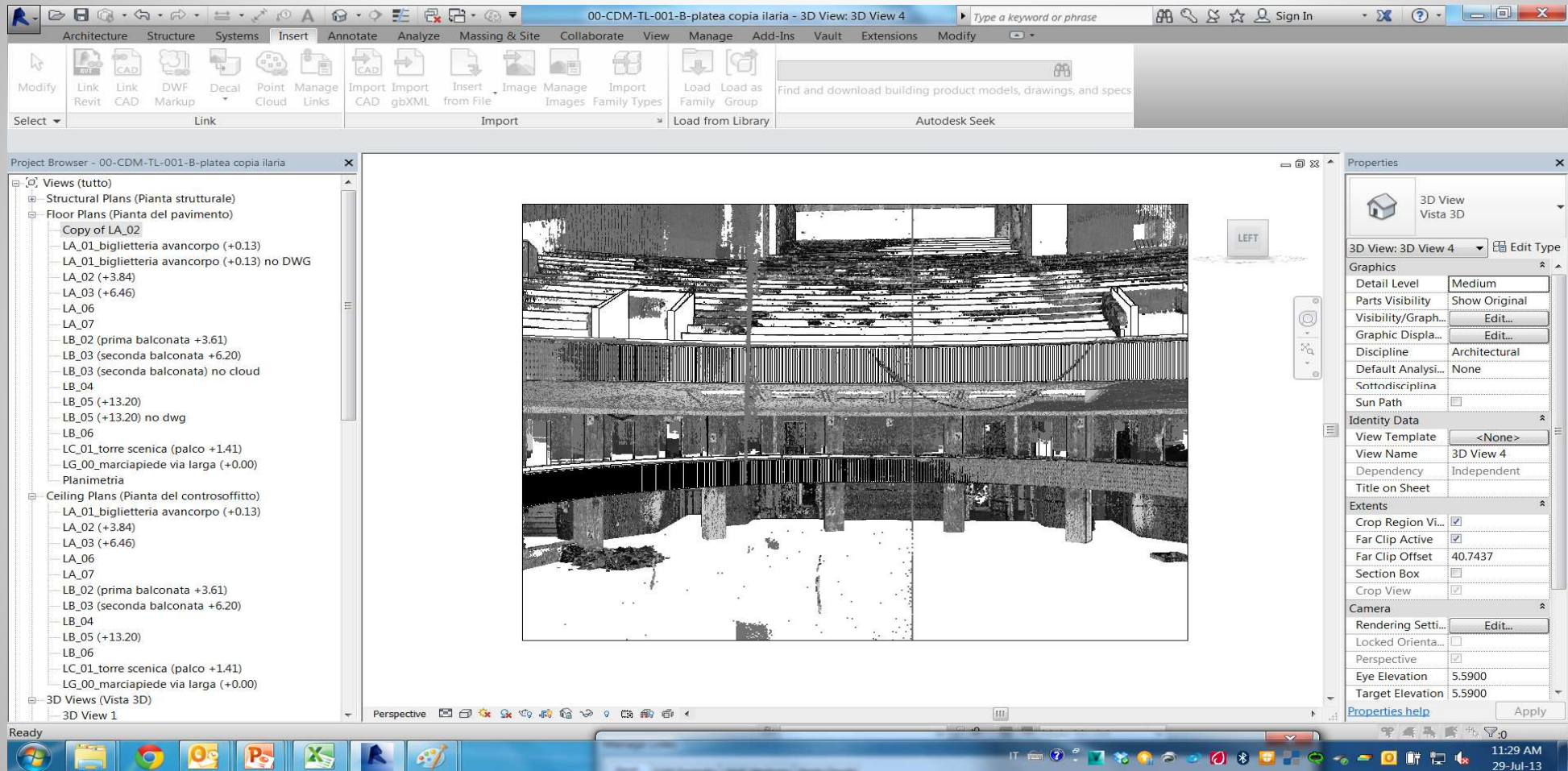
Autodesk ReCap / Revit connection allows a perfect conversion of survey data in a three-dimensional model.



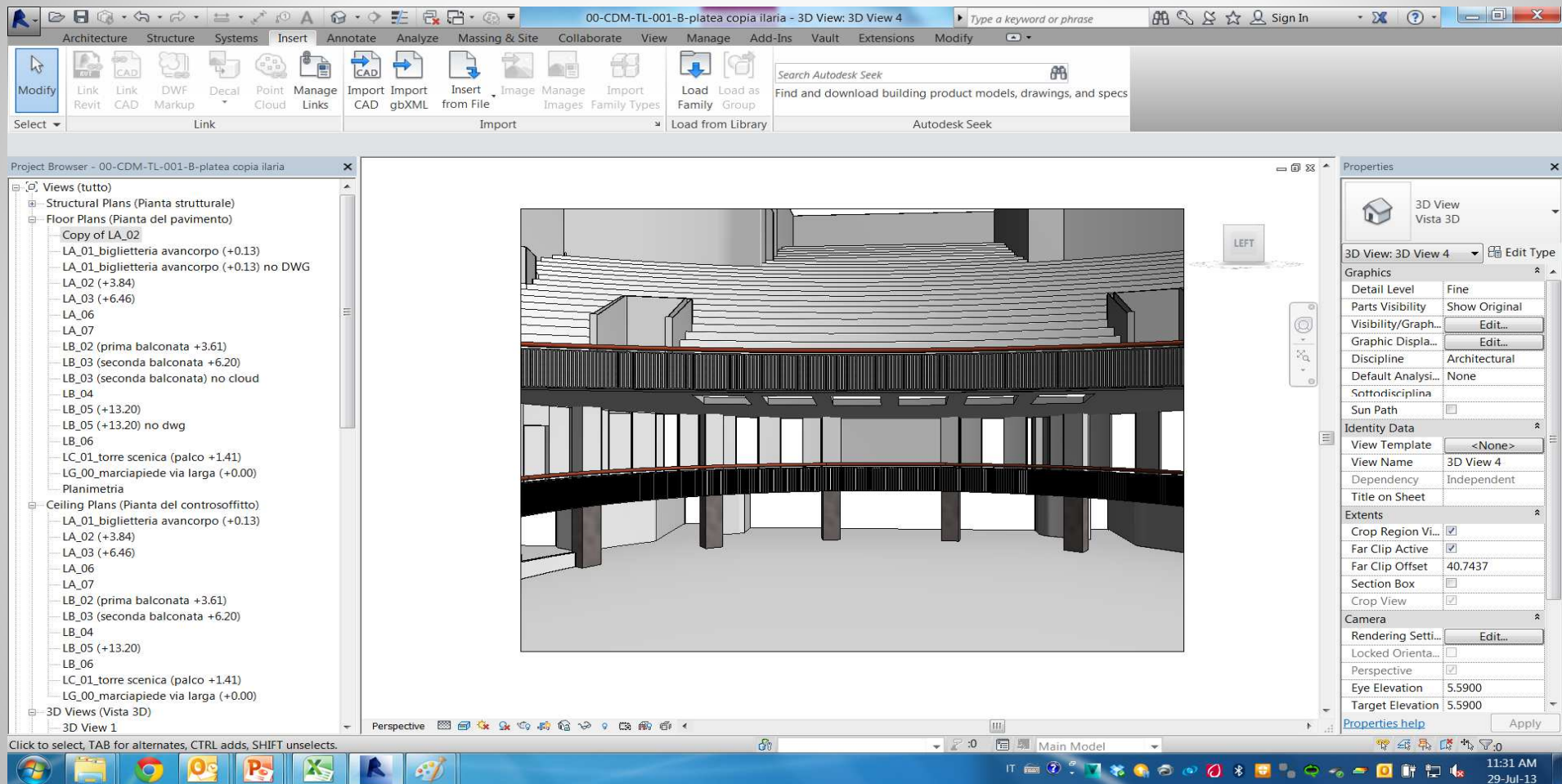
The management of point clouds in Revit allows control of every single element for the determination of every aspect and characteristic

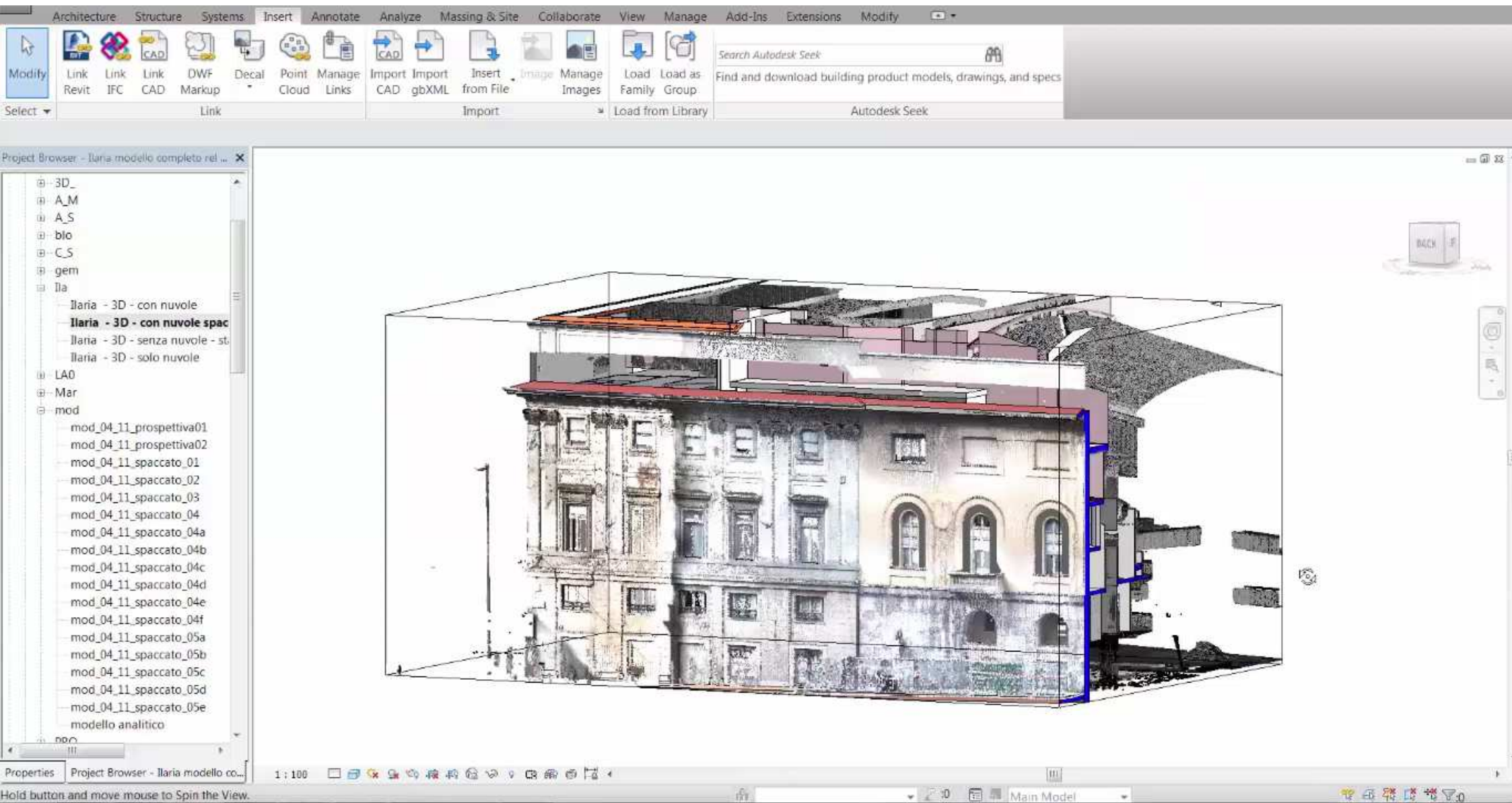


The Digitalization Process

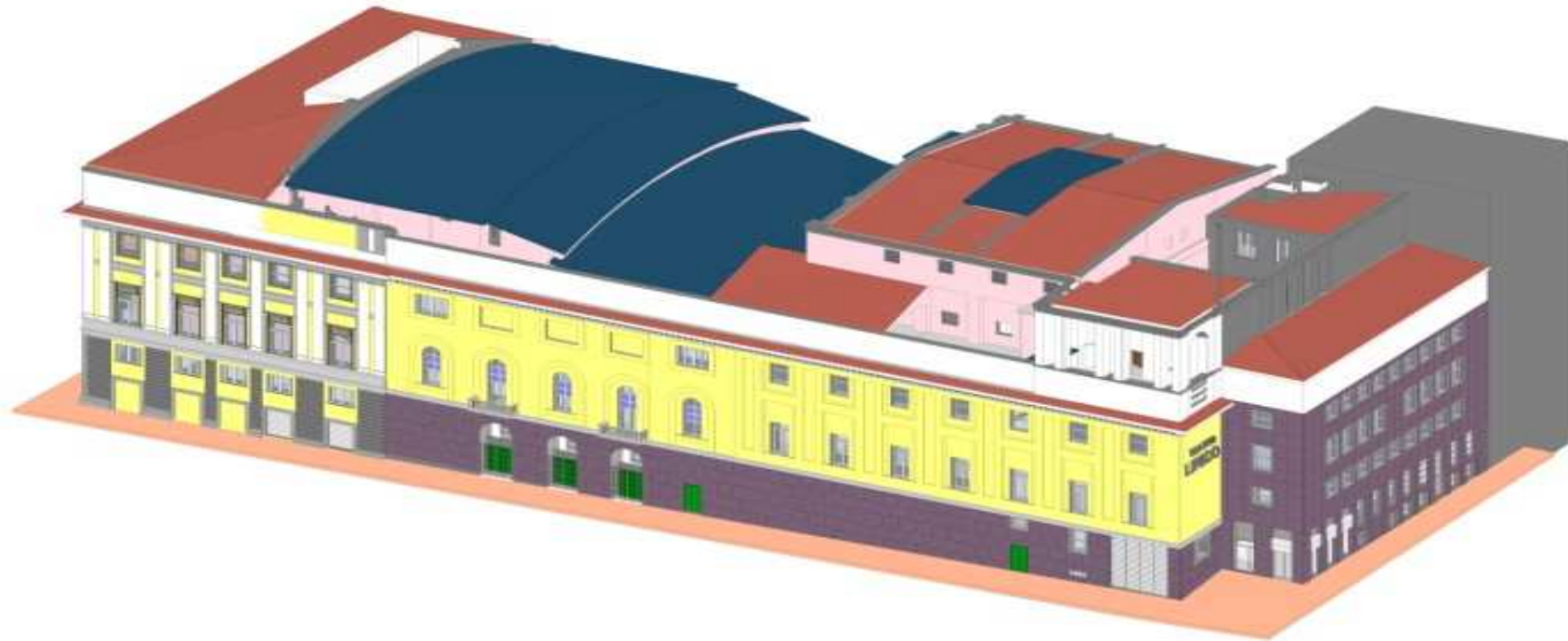


The Digitalization Process



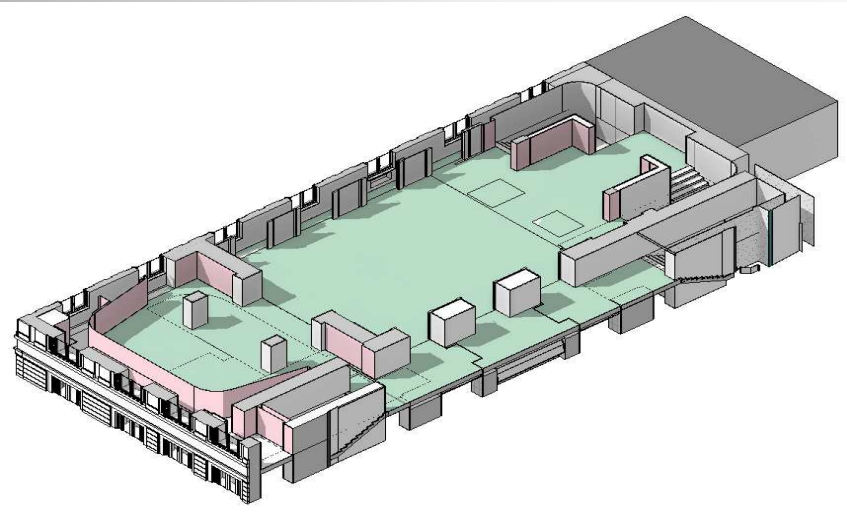


The Model

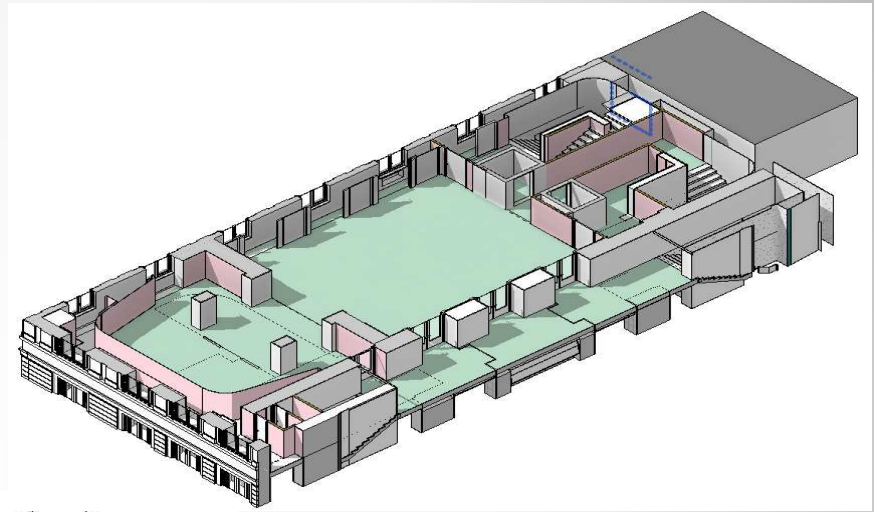


The creation of the model allows checking and verifying the construction of the objects in each phase of the project and from any point of view

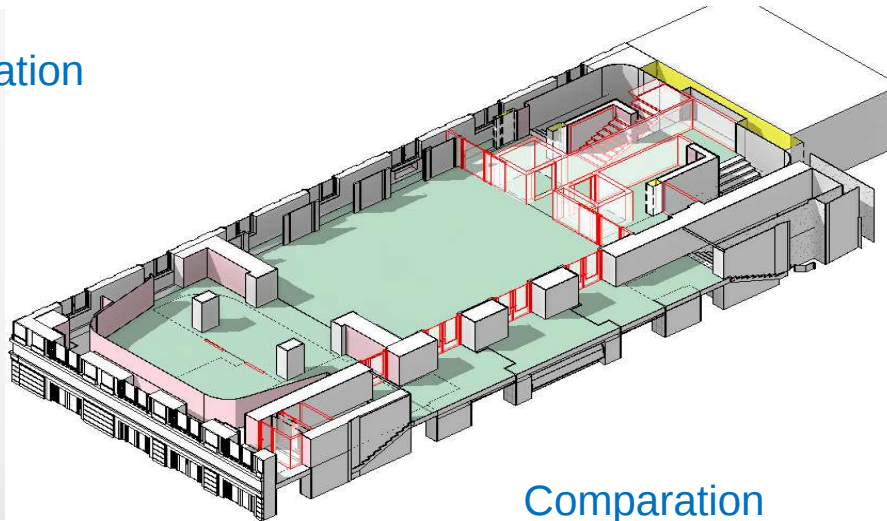
Project options evaluation



Actual situation

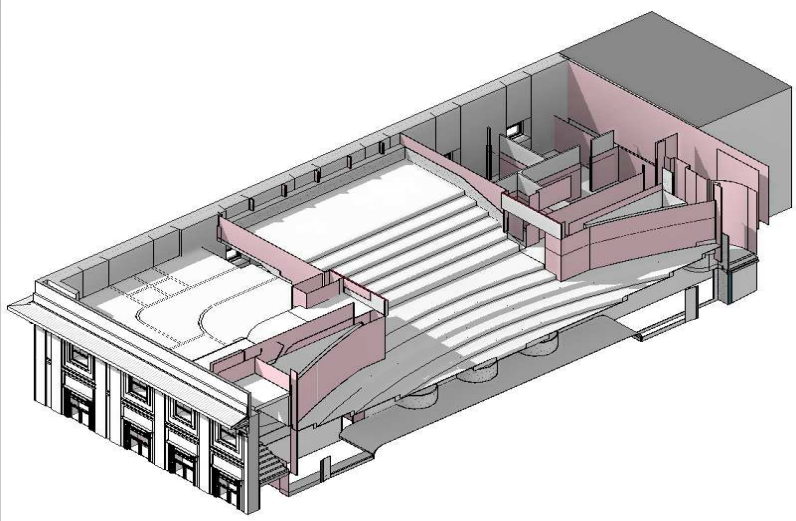


Project

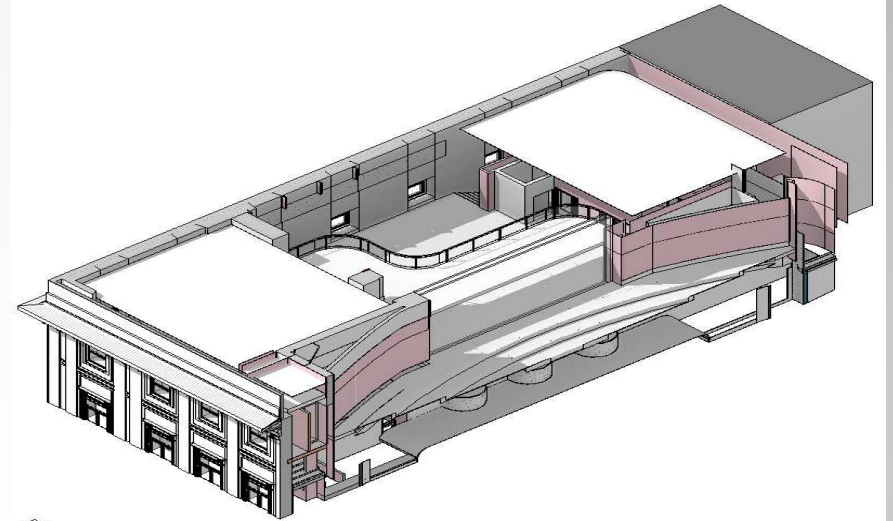


Comparison

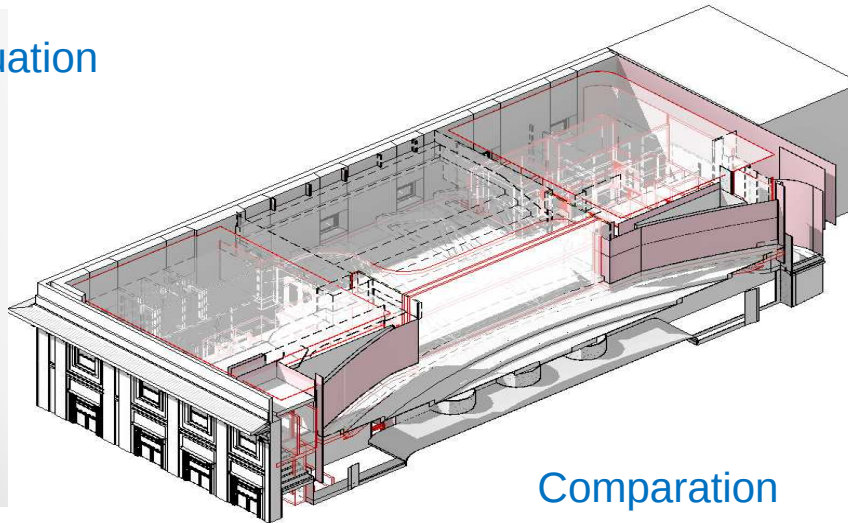
Project options evaluation



Actual situation

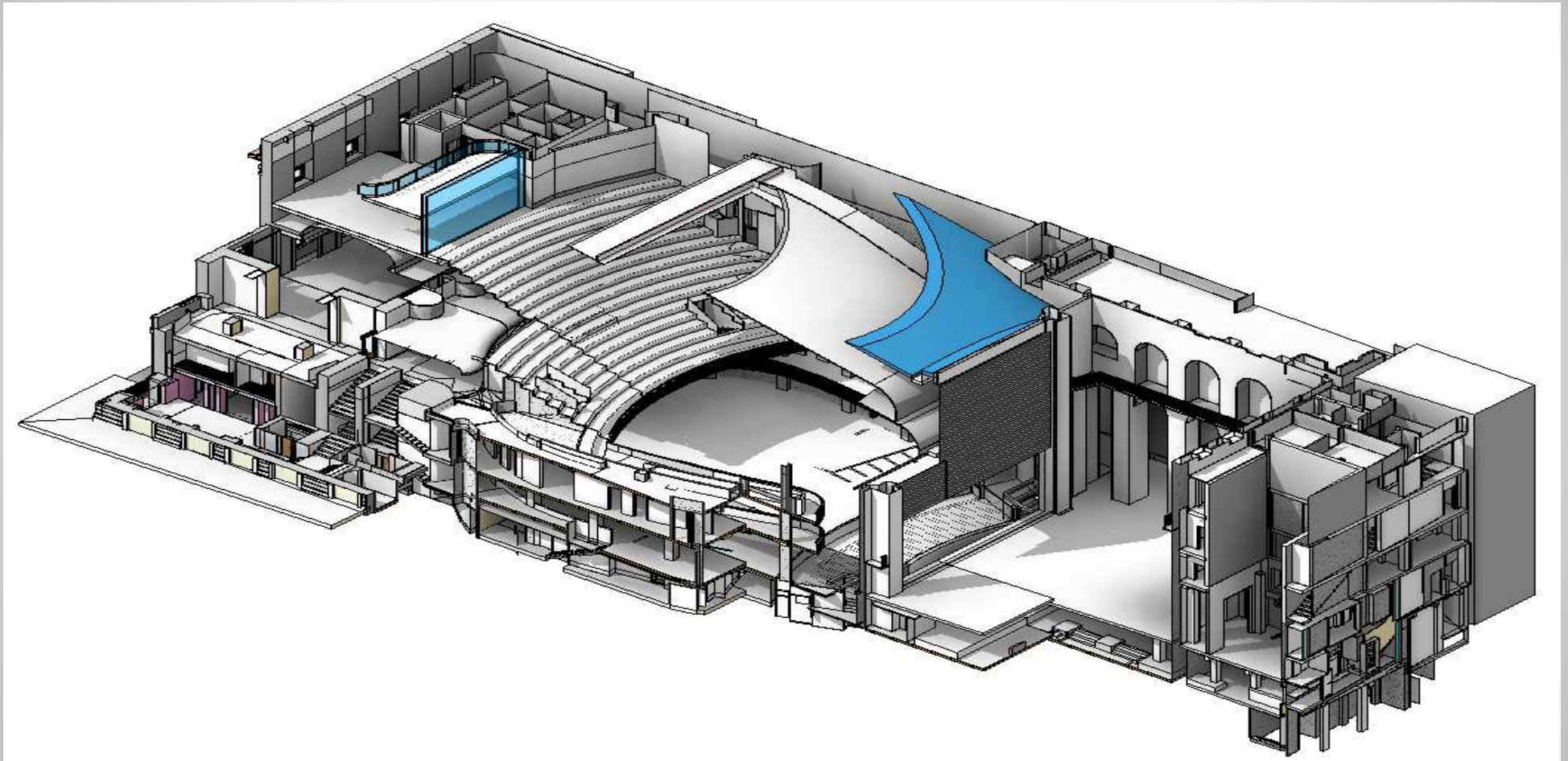


Project

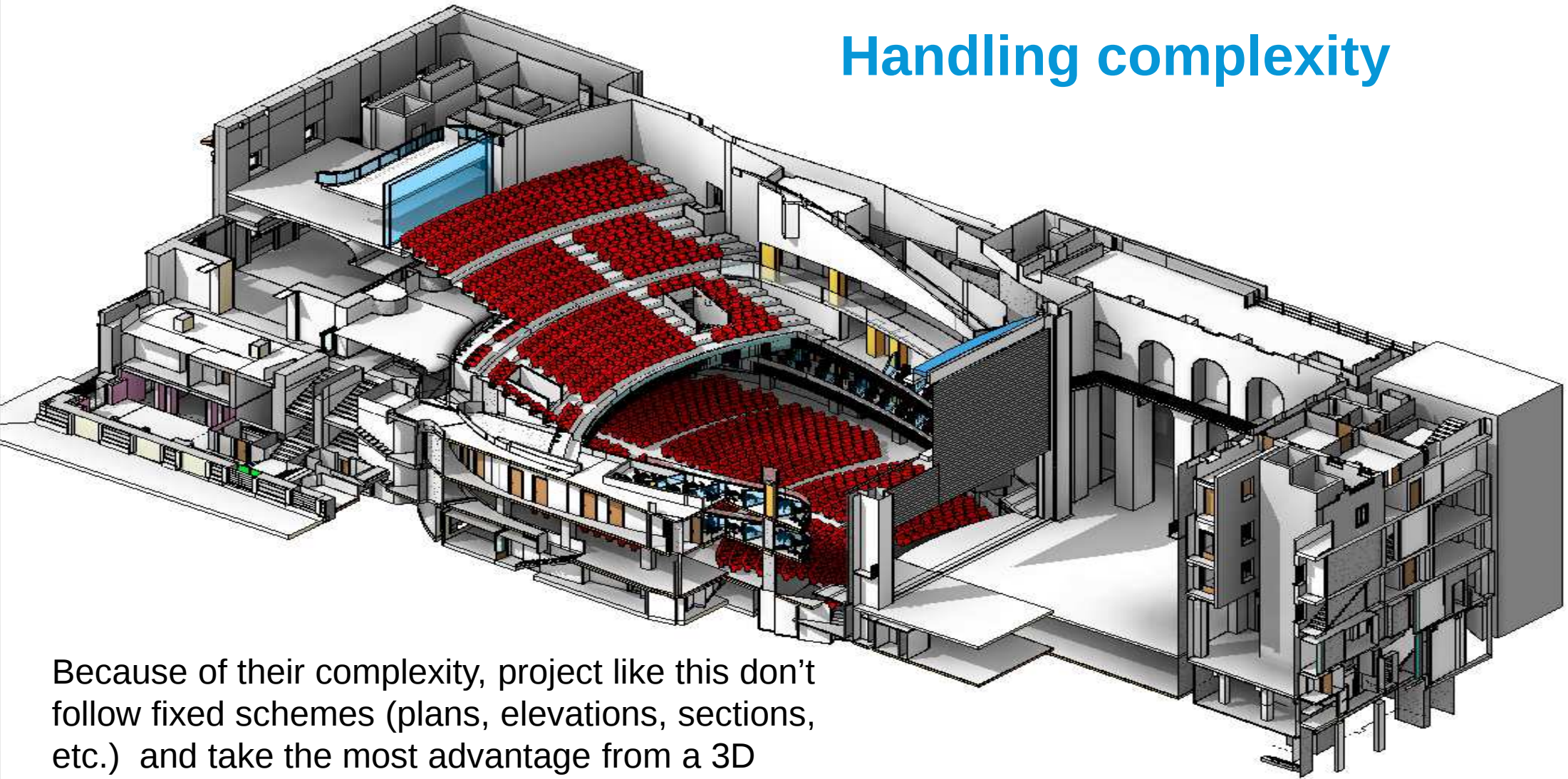


Comparison

Project options evaluation

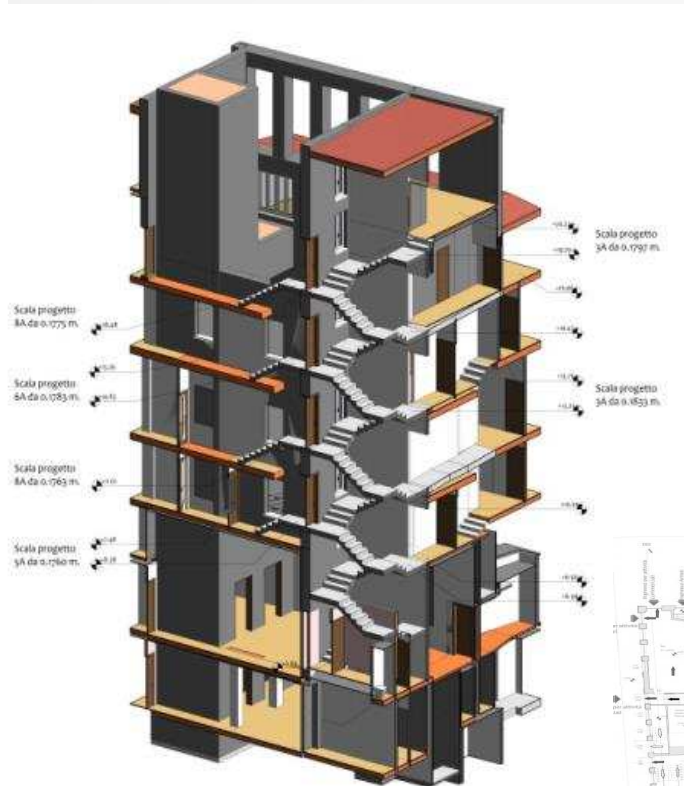


Handling complexity

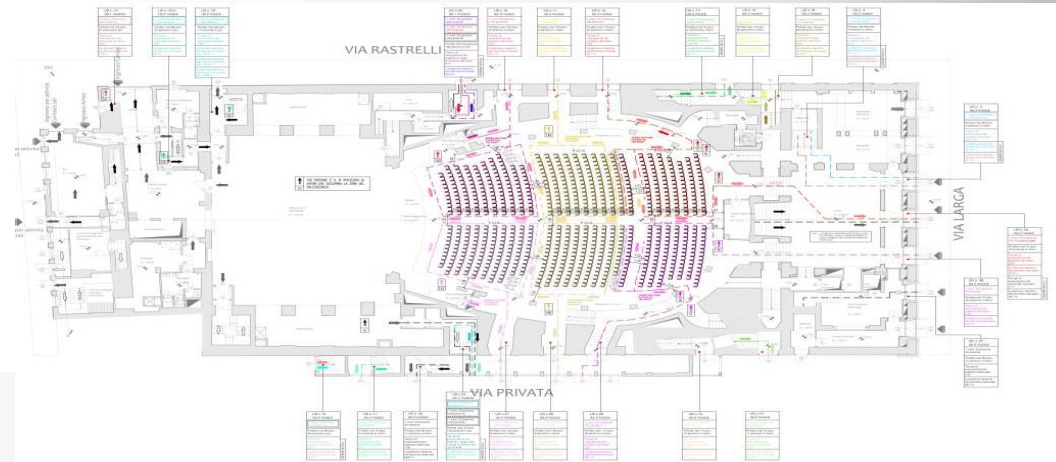


Because of their complexity, project like this don't follow fixed schemes (plans, elevations, sections, etc.) and take the most advantage from a 3D model



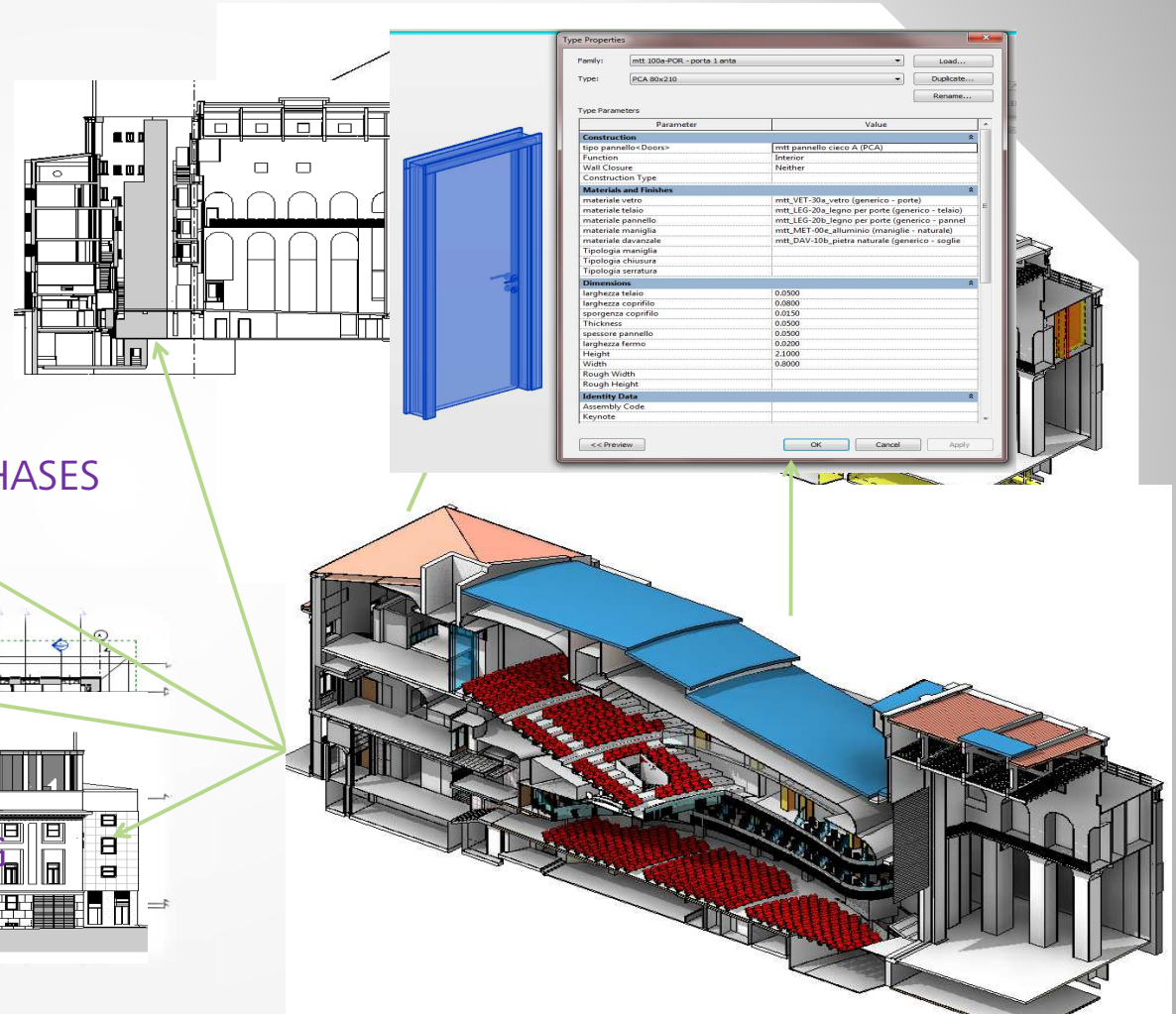
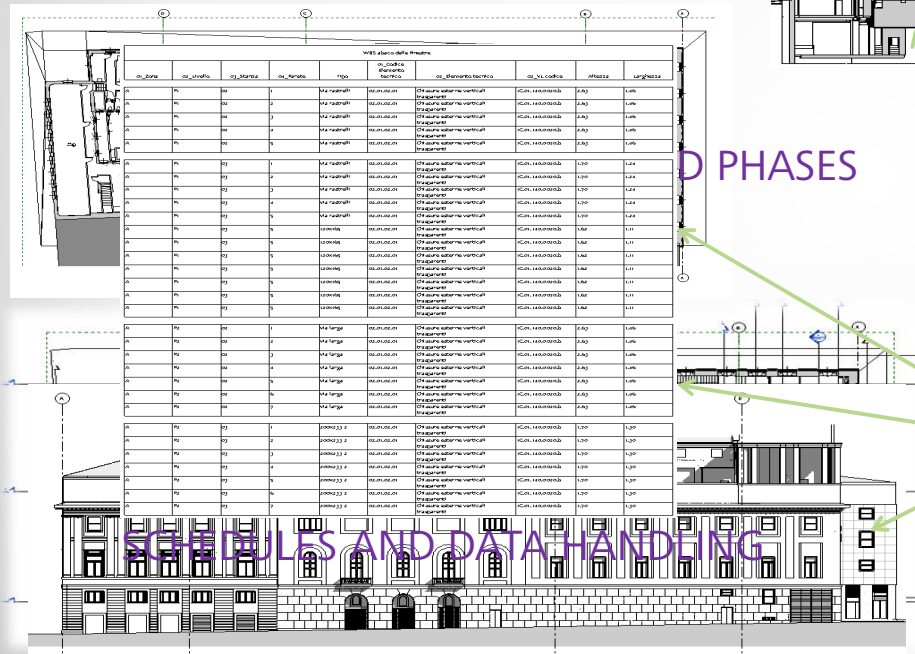


See how it was possible to check and fix all the levels according to the stairs renovation as well as simulation of evacuation ways



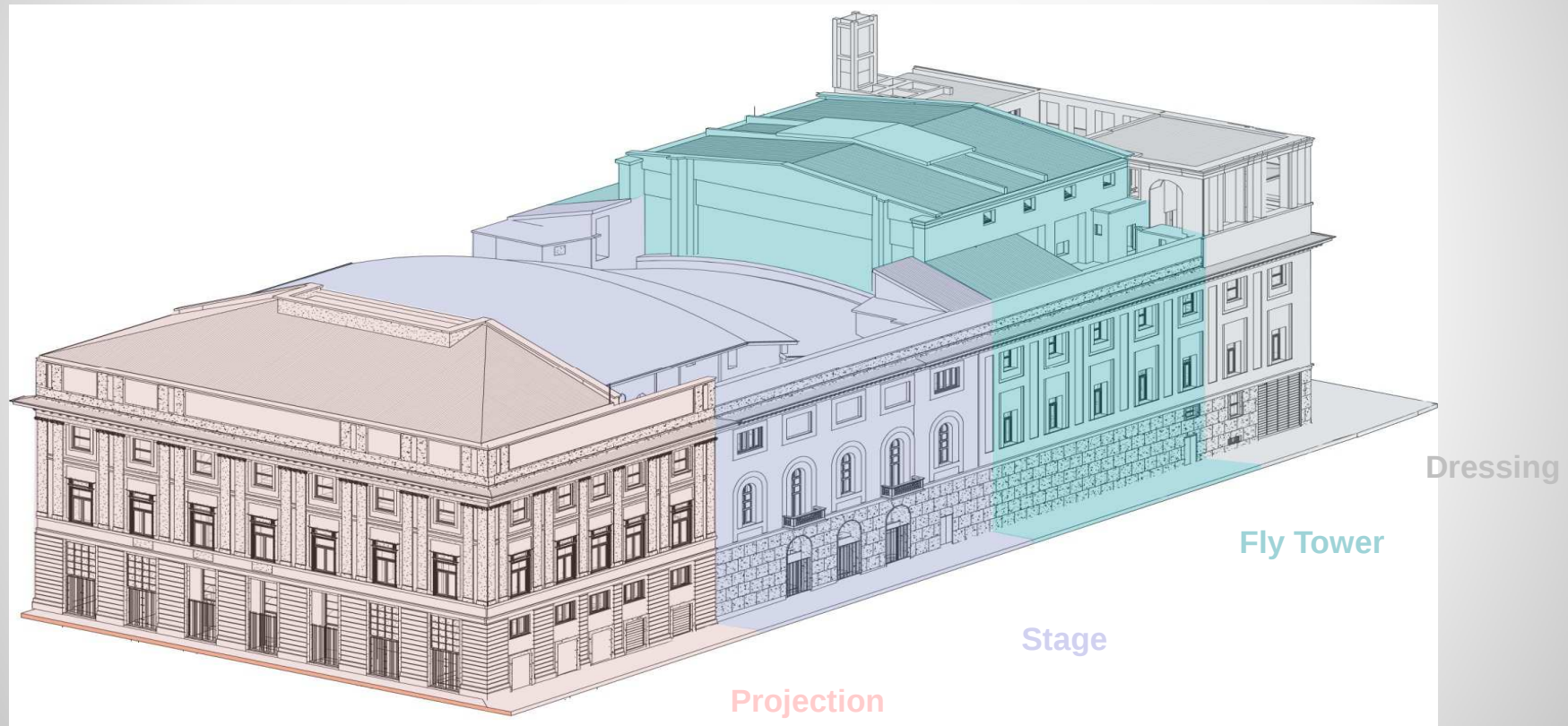
Handling complexity

BIM is an effective tool for restitution and understanding of all aspects related to the design and operation of the building



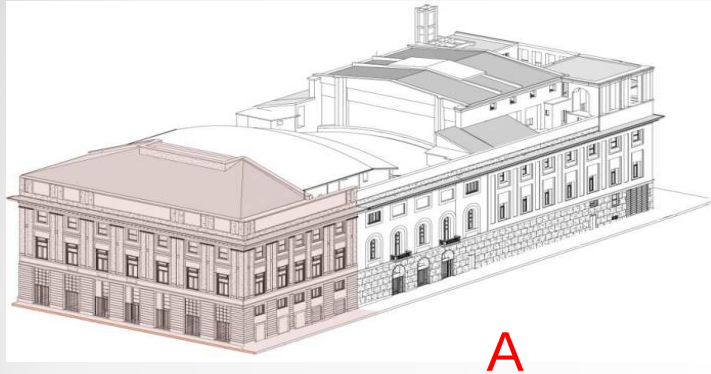
Components localization

The building complexity required it to be splitting in parts



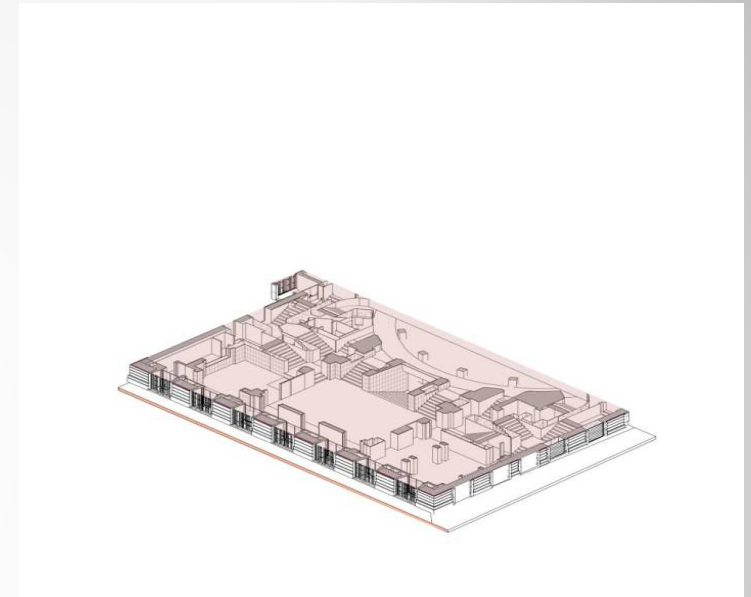
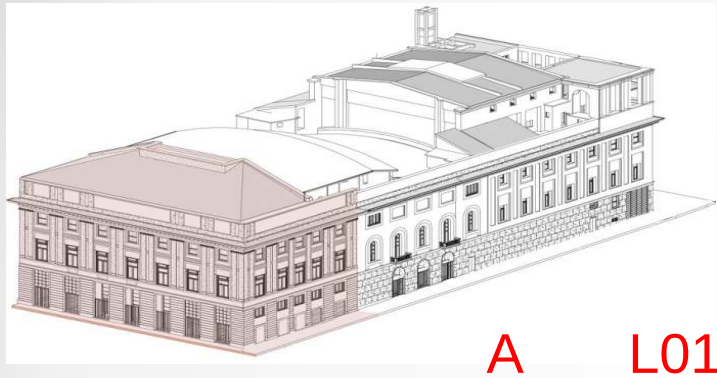
Components localization

In each Part Levels are defined



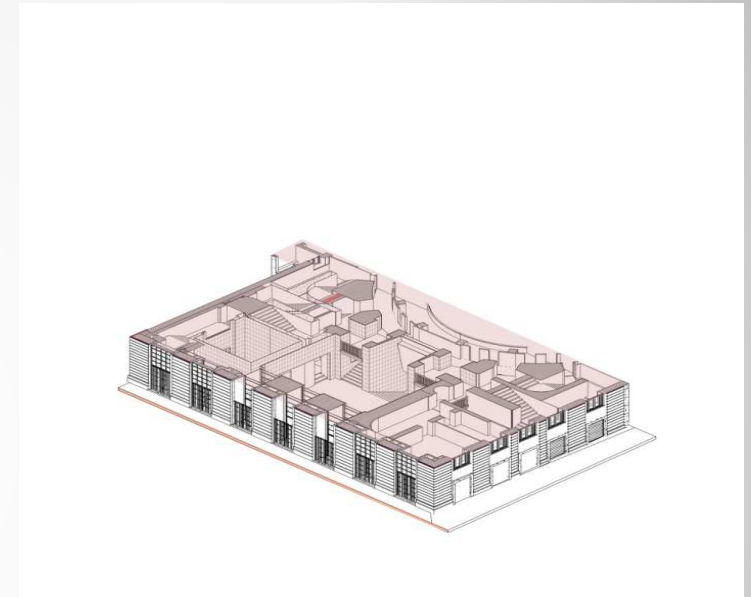
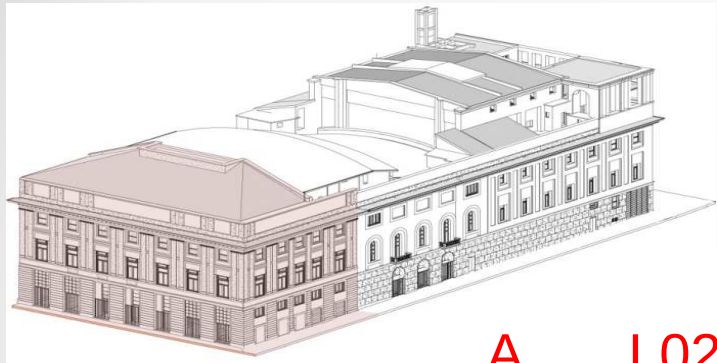
Components localization

In each Part Levels are defined



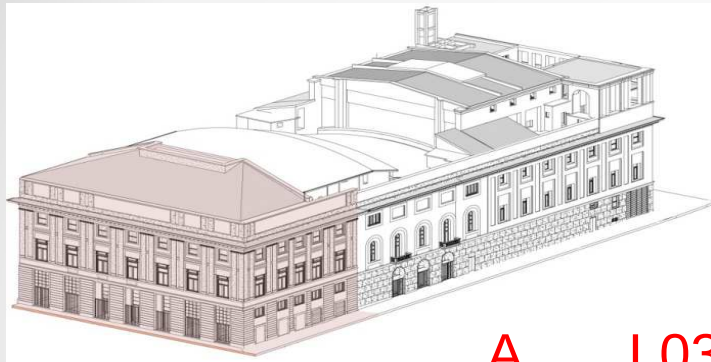
Components localization

In each Part Levels are defined

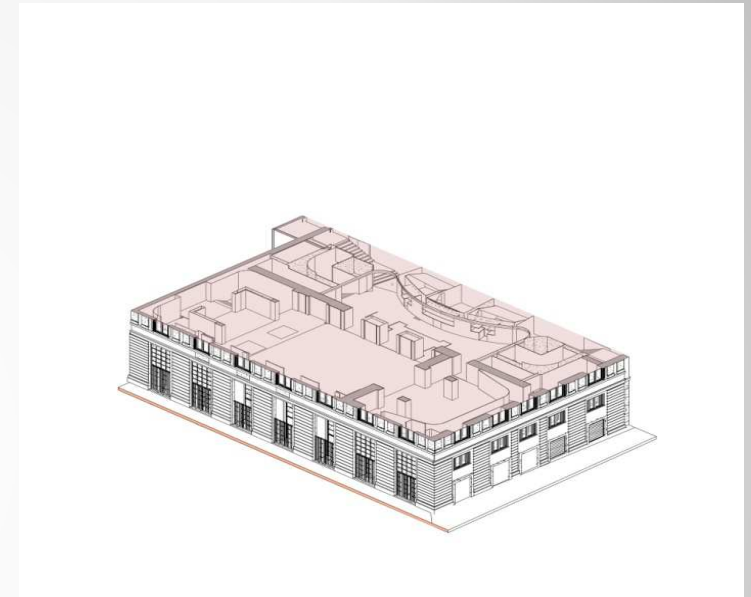


Components localization

In each Part Levels are defined

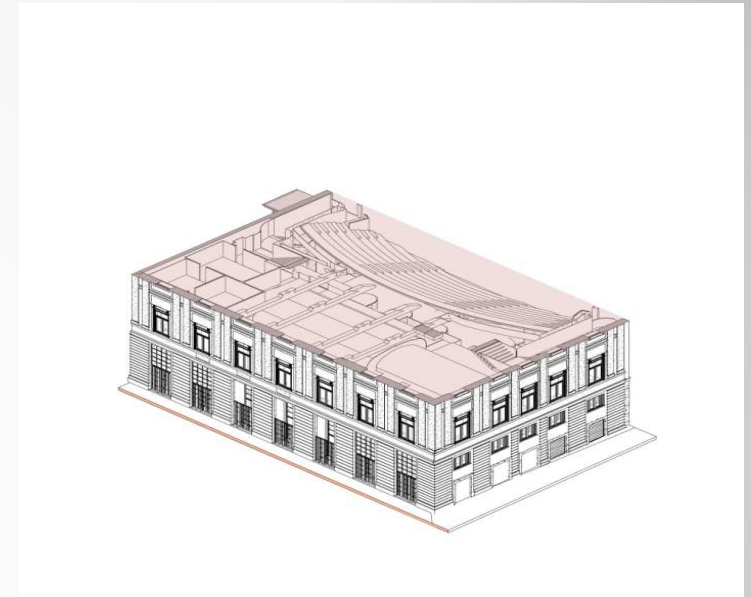
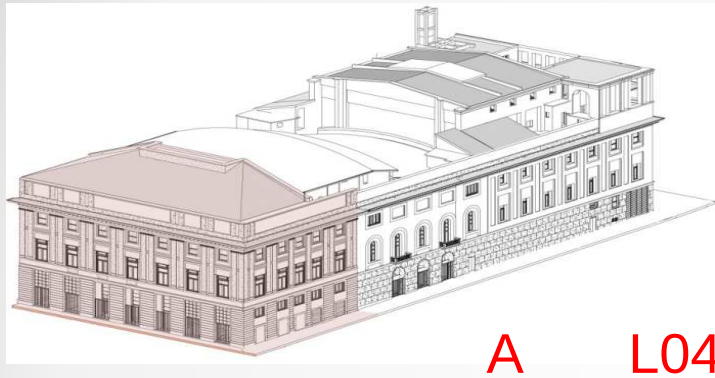


A L03



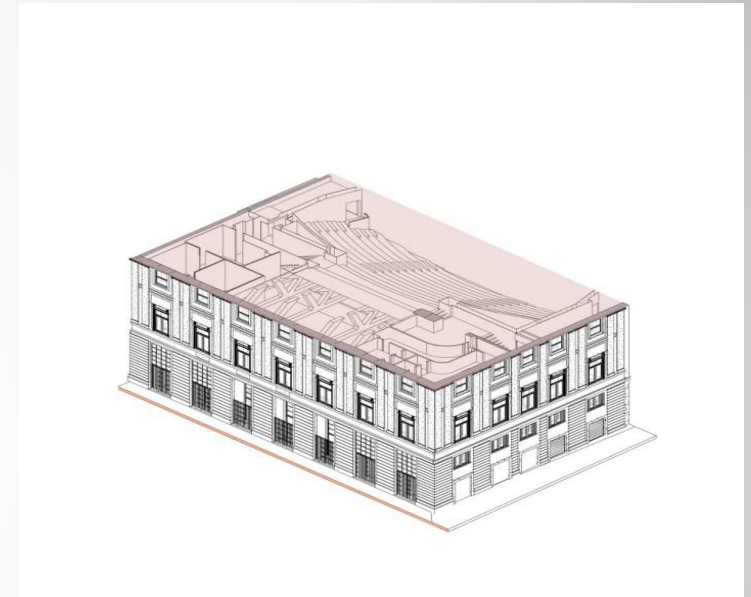
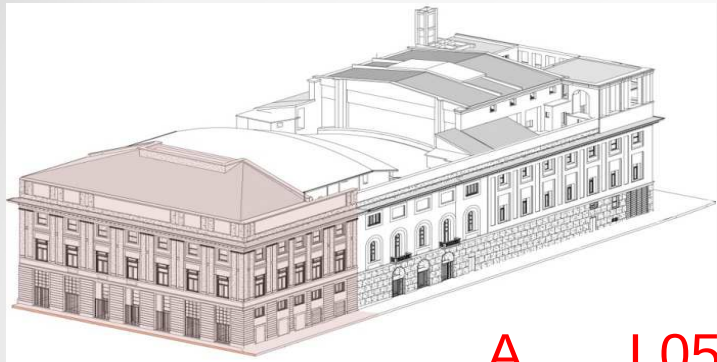
Components localization

In each Part Levels are defined



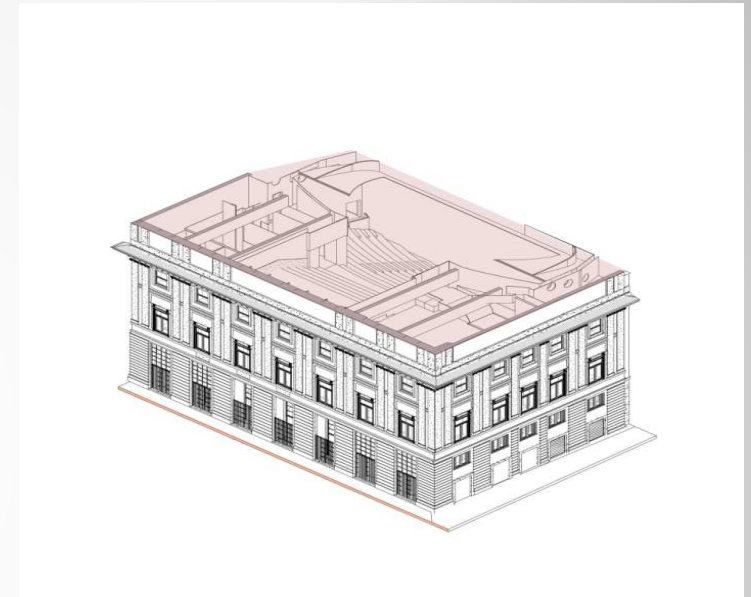
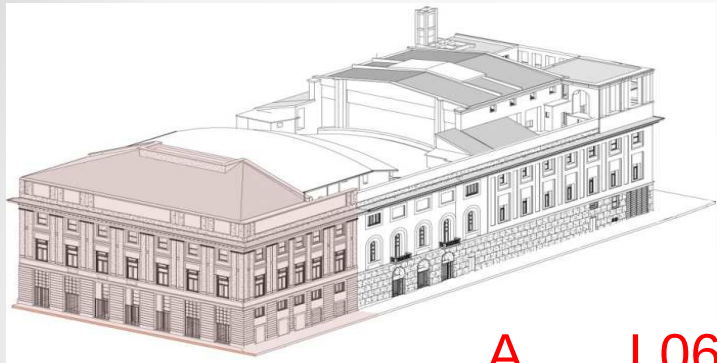
Components localization

In each Part Levels are defined



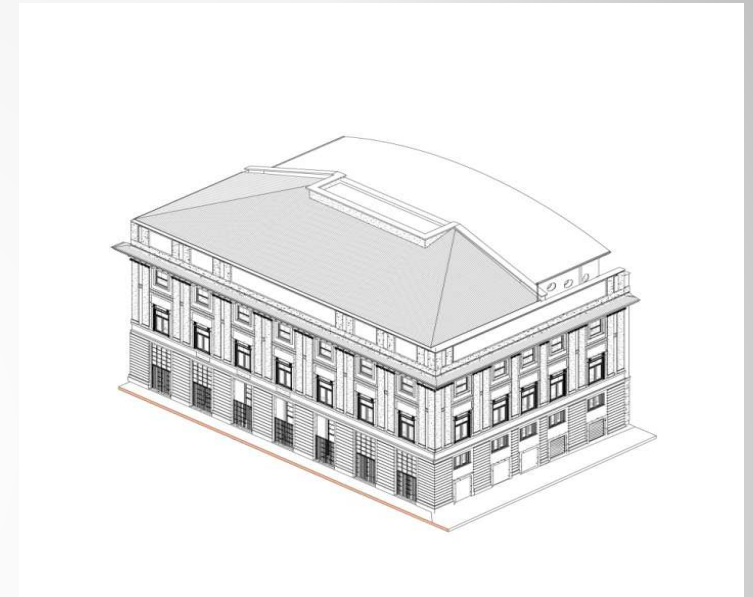
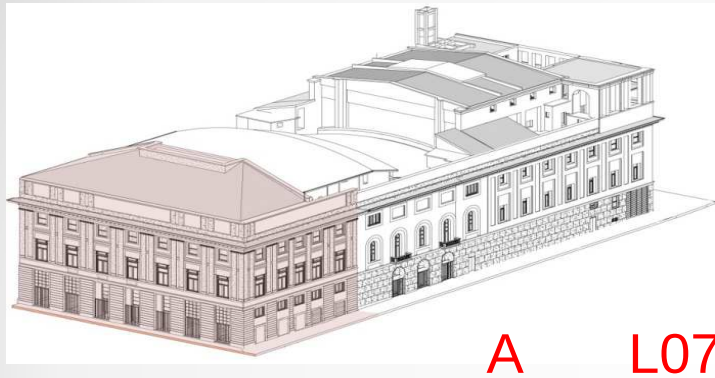
Components localization

In each Part Levels are defined



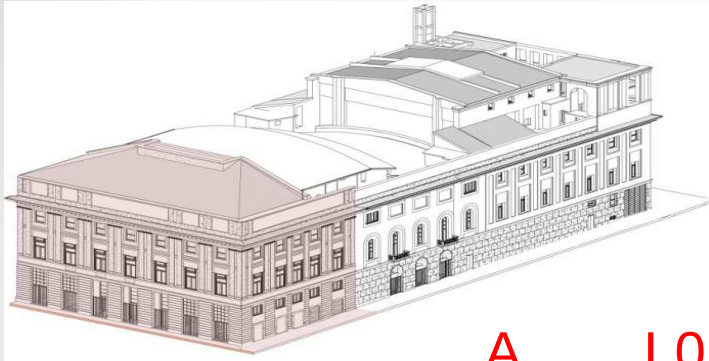
Components localization

In each Part Levels are defined

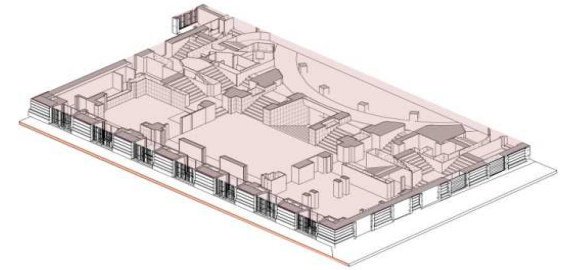


Components localization

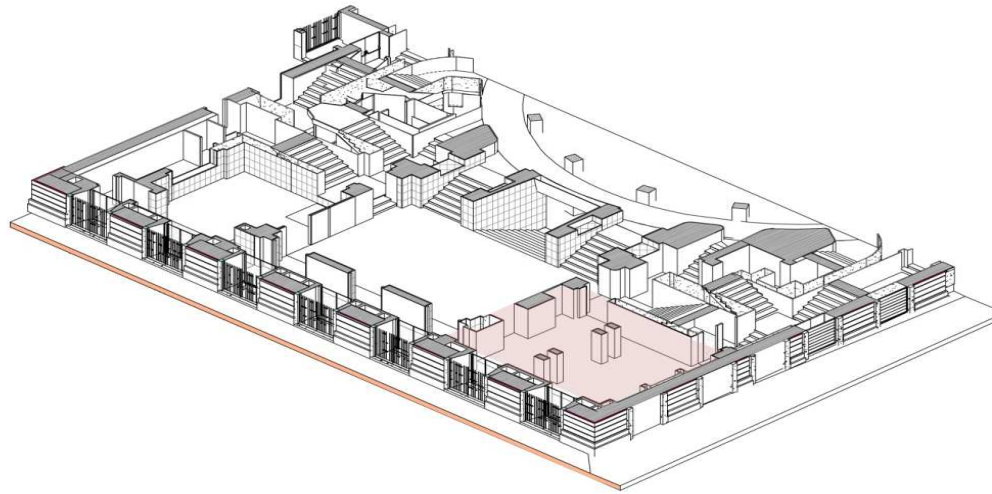
In each Part Levels are defined



A L01 01



In each Level, Rooms are defined



Components localization

In each Room, Components are defined

The diagram illustrates the process of localizing components in a room. It starts with a 3D model of a building, which is then shown in a 2D floor plan. A specific room, labeled 'AL01-01a', is highlighted with a red oval. The room is divided into four numbered components: 1 (top wall), 2 (right wall), 3 (bottom wall), and 4 (left wall). A red arrow points from component 1 to the 'Proprietà' (Properties) window, and another red arrow points from the 'Proprietà' window to the 'Modifica insieme' (Modify assembly) window.

Proprietà (Properties) window:

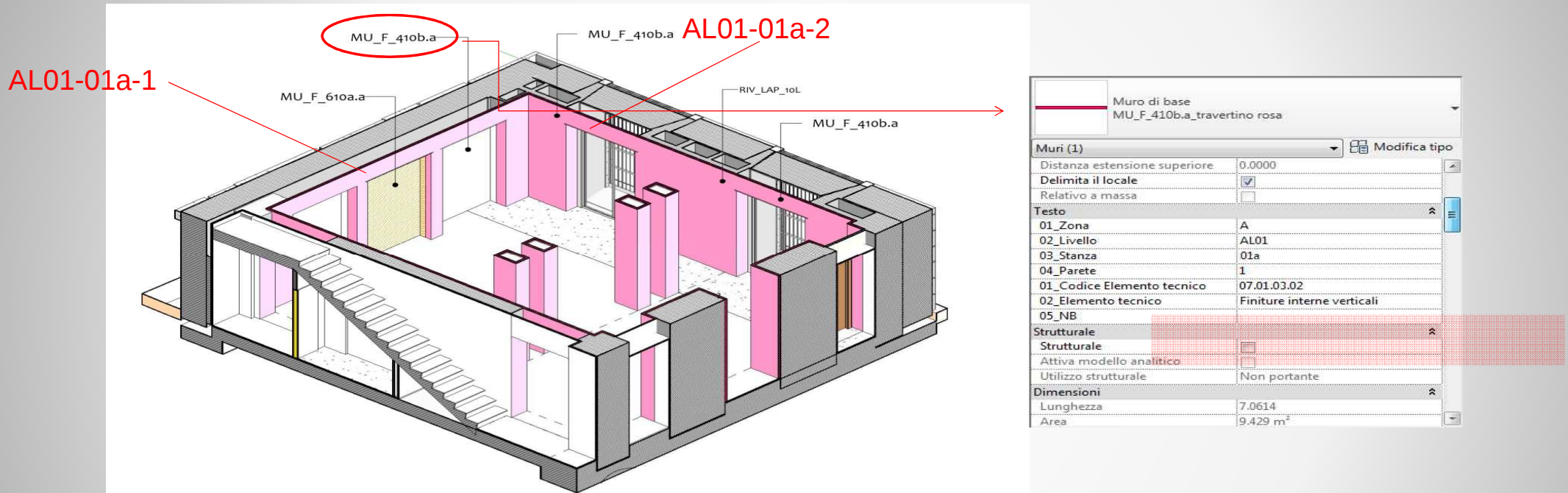
Muro di base MU_F_310a.a_intonaco rustico+ rasatura a gesso e pittura	
Muri (1)	Modifica tipo
La parte superiore è associata	☒
Distanza estensione superiore	0.0000
Delimita il locale	☒
Relativo a massa	☐
Testo	
01_Zona	A
02_Livello	AL01
03_Stanza	.01 a
04_Parete	1
01_Codice Elemento tecnico	07.01.03.02
02_Elemento tecnico	Finiture interne verticali
05_NB	NICCHIA
03_ID SC	07.01.03.02.01
04_Stato di Consistenza	Intonaco a gesso (buona con...
02a_Stanza secondaria	
03a_ID SC_Secondario	
04a_Parete secondaria	
04a_Stato di consistenza secon...	

Modifica insieme (Modify assembly) window:

Muro di base MU_F_310a.a_intonaco rustico+ rasatura a gesso e pittura				
Tipo: MU_F_310a.a_intonaco rustico+ rasatura a gesso e pittura				
Spessore totale: 0.0350 Altezza esempio: 0.0000				
Resistenza (R): 0.0000 (n+Q)/N				
Massa termica: 0.00 kg/m²				
Strati				
Funzione	Materiale	Spessore	Chiusura	Materiale strutturale
1 Contorno del v Strato sopra c	0.0000			
2 Finitura 2 (1)	FIN_INT_10A	0.0150		
3 Finitura 2 (1)	FIN_INT_10A	0.0150		
4 Struttura (1)	STR_INT_10A	0.0150		
5 Contorno del v Strato sotto c	0.0000			

Components localization

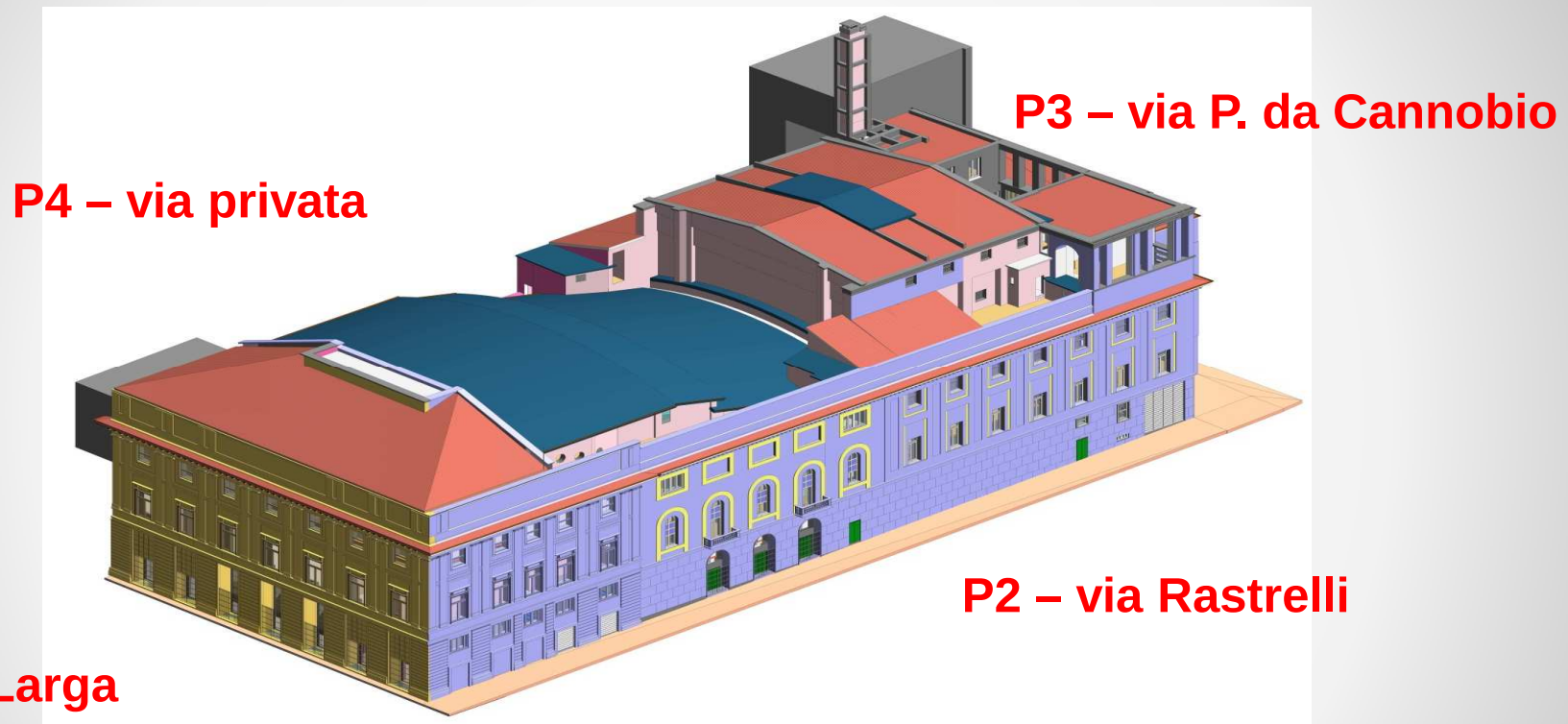
Example:
Vertical Internal Finishing F.I.V. 07-01-03



290 IMPLEMENTATA (UNIFORMAT II)				STATO DI FATTO		LOCALIZZAZIONE	ID SC	STATO DI CONSISTENZA	NOTA BENE
Unità tecnologiche		Classe di elementi tecnici		Elementi tecnici					
ID UT	Nome	ID CET	Nome	ID ET	Nome				
				07.01.03.02	Finiture interne verticali +0,13 m	A-L01-01a.1	07.01.03.02.01	Rivestimento in botticino in lastre accostate; - deposito superficiale di varia natura (particellato terroso, carbonioso...) - presenza di aloni - degrado differenziale - opacizzazione della superficie	

Components localization

Example:
Vertical External Finishing F.E.V.

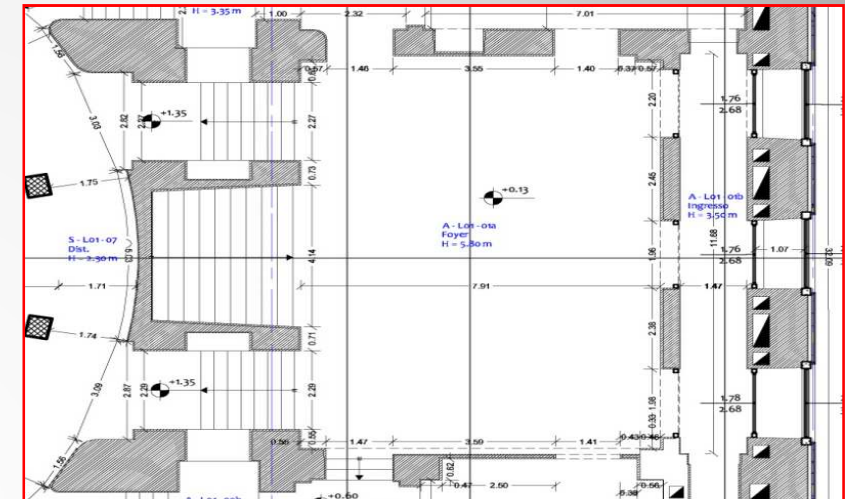


UNI 8290 IMPLEMENTATA (UNIFORMAT II)						STATO DI FATTO		LOCALIZZAZIONE	ID SC	STATO DI CONSISTENZA	NOTA BENE
Classe unità		Unità tecnologiche		Classe di elementi		Elementi tecnici					
ID CUT	Nome	ID UT	Nome	ID CET	Nome	ID ET	Nome				
7	Finiture	07.02	Finiture esterne	07.02.01	Finiture esterne orizzontali inferiori Prospetti	07.02.01.01	Finiture esterne orizzontali inferiori Prospetto 1	A-P1-01.5	07.02.01.01.01	Davanzale in materiale lapideo con pitturazione: -deposito superficiale -esfoliazione	



Components localization

Components localization is identified in Revit Schedules according to WBS and included in the Tender documentation. As BIM is not yet included in Italian regulations documentation had to be provided in a traditional format, extracted from the BIM model.



LOCALIZZAZIONE	ID SC	DISTINTA VOCE DI PREZZO							QUANTITA'	IMPORTI			
		ID VL	ID Listino	Voce da Listino Prezzi Comune di Milano 2013	Unità di misura	Lavorazioni P.U.	Sicurezza P.U.	Manodopera %		IMP. Lavorazioni	IMP. Sicurezza	IMP. Manodopera	TOTALE LAVORAZIONE
A-L01-01a.1	07.01.03.02.01	07.01.03.02.01.01	PA.C.034	Verifica della stabilità delle lastre di rivestimento in materiale lapideo attraverso la battitura, compreso piani di lavoro.	m²	7,1	0,03	80,42%	24,31	172,80	0,73	128,81	173,33
		07.01.03.02.01.02	IC.25.180.0010	Asportazione a secco di depositi superficiali incoerenti (polveri, terriccio, guano ecc.) mediante aspiratori, spazzole, pennellesse.	m²	14,49	0,12	9,73%	24,31	362,26	2,92	34,27	365,17
		07.01.03.02.01.03	IC.24.050.0020	Pulizia di superfici esterne verticali ed orizzontali, intonacate e/o lapidee, mediante idrolavaggio a bassa pressione con soluzione satura di bicarbonato di sodio o miscela di carbonati, compreso accurato lavaggio finale. Risultano inoltre compresi i piani di lavoro e le assistenze murarie.	m²	26,7	0,21	46,90%	24,31	649,08	5,11	304,42	654,18
		07.01.03.02.01.04	IC.25.200.0010.1	Rimozione di vecchie stuccature di fughe e giunti tra manufatti in marmo, calcari, breccie, travertino, a base di resine sintetiche solubili.	m	11,22	0,09	9,31%	8,13	91,22	0,73	8,49	91,95
		07.01.03.02.01.05	IC.25.250.0010.1	Stuccatura con malta di gesso rispondente alle caratteristiche di quella originale per colorazione e granulometria, per giunti, fessure.	m	16,04	0,13	9,42%	8,13	120,41	1,06	12,28	131,46
		07.01.03.02.01.06	IC.17.200.0020	Lucidatura in opera di pavimenti in lastre di marmo o pietre tenere, con superficie già levigata, compresa assistenza muraria e pulizia finale.	m	14,66	0,06	70,74%	8,13	119,19	0,49	84,31	119,67
		07.01.03.02.02	IC.01.090.0030	Piscinatura di intonaco in buono stato per rendere la superficie sobria ed idonea a ricevere successivi rivestimenti. Compresi piani di lavoro, polveratura, pulizia ed allori annessi dei detti.	m²	5,85	0,19	76,16%	13,99	81,84	2,66	62,33	84,50
		07.01.03.02.02.02	IC.07.230.0020	Rasatura liscia su superfici interne, verticali ed orizzontali, in ambienti di qualsiasi dimensione, eseguita con rasante a base di calce e gesso, inerti selezionati, additivi, applicato su preesistente intonaco rustico base gesso e anidrite, su pannelli di gesso, blocchi in calcestruzzo cellulare, compresi i piani di lavoro.	m²	10,65	0,09	62,76%	13,99	148,99	1,26	93,51	160,26
		07.01.03.02.02.03	IC.24.160.0020.1	Trattamento di superfici, prima di eseguire rasature, stuccature o pitture, compresi piani di lavoro interni ed assistenze murarie. Con applicazione a rullo o pennello di:	m²	4,56	0,04	67,93%	10,25	46,96	0,41	27,20	47,36
		07.01.03.02.02.04	IC.24.120.0020.1	Pitturazione a due riprese, su superfici interne, in intonaco civile o lisciate a gesso, già preparate ed isolate. Compresi piani di lavoro ed assistenze murarie. Con diluizione a base di resine in emulsione, cariche micronizzate, additivi, battericidi, fungicidi - a base di copolimeri vinilacetati, traspirante (p.s. 160 kg/l, resa 0,13-0,16 l/m²). Lavabilità - 1.000 cicli spazzola (DIN 53778).	m²	5,62	0,05	63,22%	13,99	78,62	0,70	49,71	79,32
		07.01.03.02.03.01	PA.C.034	Verifica della stabilità delle lastre di rivestimento in materiale lapideo attraverso la battitura, compreso piani di lavoro.	m²	7,1	0,03	80,42%	41,12	291,95	1,23	234,79	293,19
		07.01.03.02.03.02	IC.25.180.0010	Asportazione a secco di depositi superficiali incoerenti (polveri, terriccio, guano ecc.) mediante aspiratori, spazzole, pennellesse.	m²	14,49	0,12	9,73%	41,12	595,83	4,93	57,97	600,76
A-L01-01a.2	07.01.03.02.03	07.01.03.02.03.03	IC.24.050.0020	Pulizia di superfici esterne verticali ed orizzontali, intonacate e/o lapidee, mediante idrolavaggio a bassa pressione con soluzione satura di bicarbonato di sodio o miscela di carbonati, compreso accurato lavaggio finale. Risultano inoltre compresi i piani di lavoro e le assistenze murarie.	m²	26,7	0,21	46,90%	41,12	1.097,90	8,64	514,32	1.106,84
		07.01.03.02.03.04	IC.25.200.0010.1	Rimozione di vecchie stuccature di fughe e giunti tra manufatti in marmo, calcari, breccie, travertino, a base di resine sintetiche solubili.	m	11,22	0,09	9,31%	7,14	80,11	0,64	7,46	80,75
		07.01.03.02.03.05	IC.25.250.0010.1	Stuccatura con malta di gesso rispondente alle caratteristiche di quella originale per colorazione e granulometria, per giunti, fessure.	m	16,04	0,13	9,42%	7,14	114,53	0,93	10,79	115,45
		07.01.03.02.03.06	IC.17.200.0020	Lucidatura in opera di pavimenti in lastre di marmo o pietre tenere, con superficie già levigata, compresa assistenza muraria e pulizia finale.	m	14,66	0,06	70,74%	7,14	104,67	0,43	74,05	105,10

2.1 Ch.Sup. 7.1.1 F.I.o.L. 7.1.2 F.I.o.S. 7.1.3 F.I.v. 7.1.4.1 F.I.o.L. 7.1.4.2 F.I.o.S. 7.1.5 F.I.v. 7.2.1 F.e.o.L. 7.2.2 F.e.o.S. 7.2.3 F.e.v. DATABASE TOT. 4



From the Model to Visualization



Autodesk 3D Studio Max and Visualization



Autodesk 3D Studio Max and Visualization



Autodesk 3D Studio Max and Visualization



Autodesk 3D Studio Max and Visualization



AUTODESK UNIVERSITY 2015

Courtesy of Comune di Milano



Conclusions

- The tender has been closed on 6° November 2015 and the winner has been requested to provide As Built in BIM format
- Starting from this experience the Customer is developing in total autonomy every project in BIM methodology
- «Comune di Milano – Direzione Centrale Tecnica» opened the road to a new trend in Italy
- New Italian Regulations in discussion included BIM as a «preferred method», even if not mandatory yet

Ing. Massimiliano Papetti, Comune di Milano Chief Technical Manager and PM of Teatro Lirico Renovation



“...the activity developed in the design field is a cultural and methodological innovation experience for the Administration. We will try to manage some building construction phases using BIM methodology...”

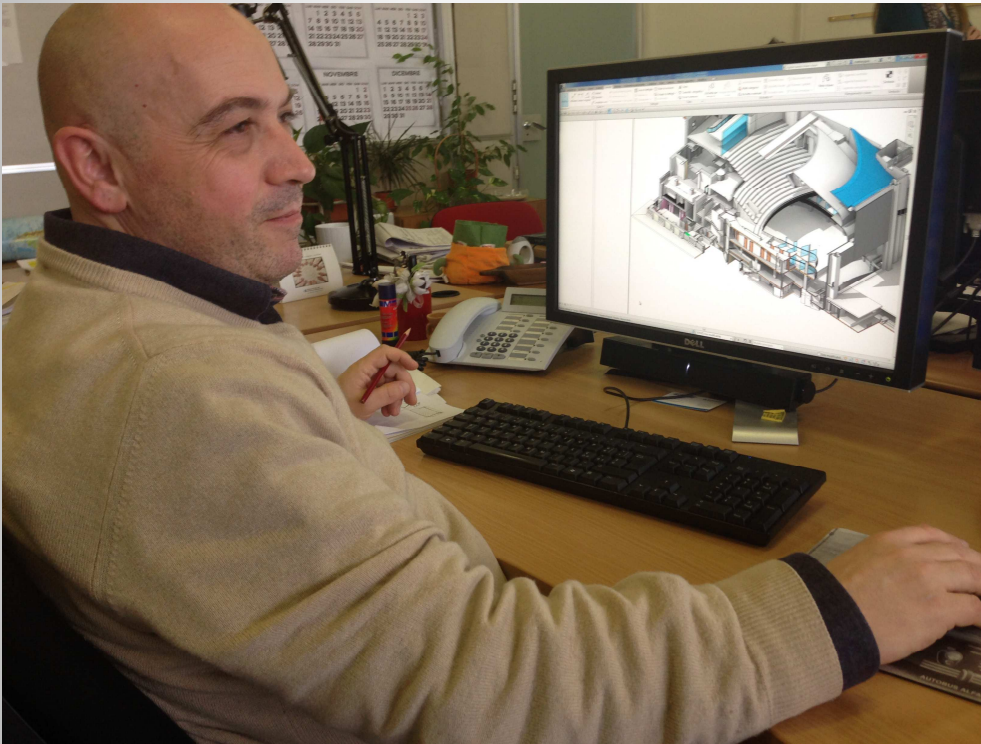


Ass. Carmela Rozza, Councilor for Milano City Public Works and Street Furniture



*".....the City Council is one of the first Public Administrations to apply BIM methodology for restoration of "Teatro Lirico", which, for Milano, after "la Scala" is the most important Opera House.
" The past looks into the future"*

Matteo Giani, BIM Manager – Autodesk Consulting



“The activity developed with the Team from the Customer for the Opera House Renovation was an incredible experience.

Working in a Pilot of this kind of importance was really challenging and it was the first time I could test my BIM experience on an historical building and demonstrate how much new technology can help in retrofitting market.

And in our Country there is so much to do in this field!”



Credits

- Images and Model Courtesy of «Comune di Milano – Assessorato dei Lavori Pubblici e Arredo Urbano»
- Scanning activity courtesy of Leica Geosystems s.p.a.

Be heard! Provide AU session feedback.

- Via the Survey Stations, email or mobile device.
- AU 2016 passes awarded daily!
- Give your feedback after each session.
- Give instructors feedback in real-time.



Too many sessions, too little time?

After AU visit:

AutodeskUniversity.com

- Recorded sessions
- Presentations and handouts
- Key learnings

Don't miss a second! Find hundreds of sessions waiting for you.



Milano



Comune
di Milano



AUTODESK

Leica
Geosystems



Milano, 11 febbraio 2014
Palazzo Marino, Sala Alessi

TEATRO LIRICO

Un nuovo progetto per Milano, un restauro per il futuro



AUTODESK UNIVERSITY 2015

Courtesy of Comune di Milano

 **AUTODESK.**

