

From BIM Requirements to Facility Management

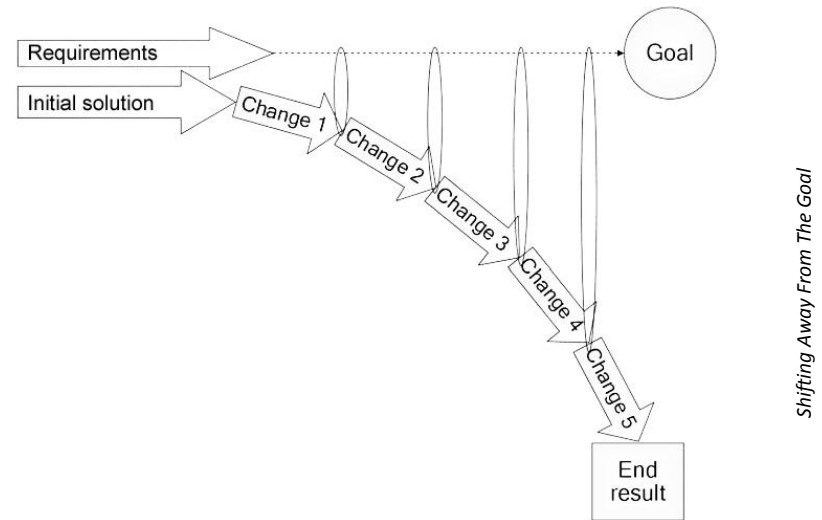
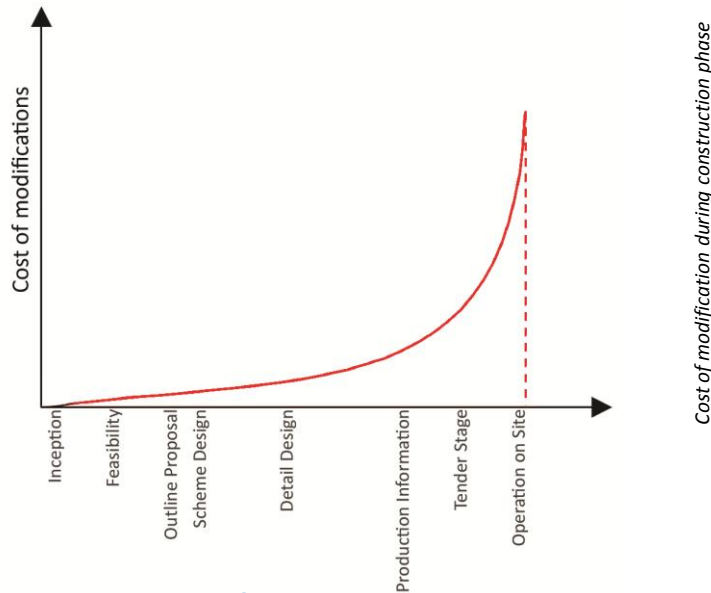
BIM based scenario in a large-scale public building

A. Ciribini, Università degli Studi di Brescia

A. Vanossi, Politecnico di Milano

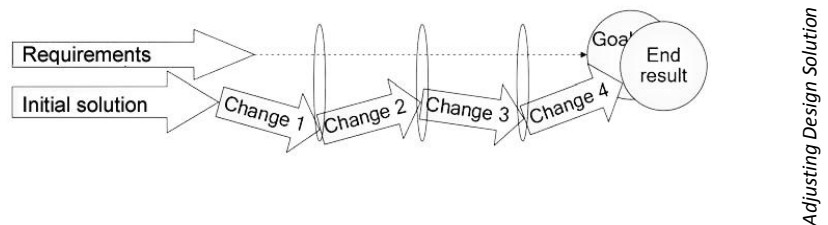
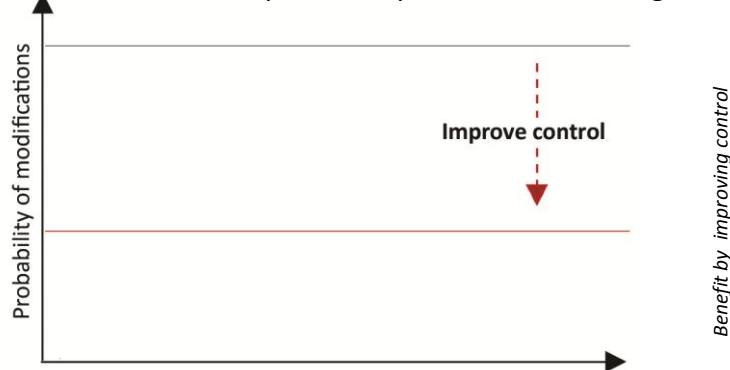
A. Tego, CMB Carpi

G. Caratozzolo, Università degli Studi di Brescia



Building Information Model

Is a **data-rich, object-oriented, intelligent and parametric digital representation** of the facility, from which **views and data** appropriate to **various users' needs** can be **extracted** and **analyzed** to generate information that can be used to **make decisions** and to improve the process of delivering the facility. (*Associated General Contractors of America: The contractor's Guide to BIM, 2005*)



RIBA (2008) and author

Arto Kiviniemi (2005), *Requirements Management Interface to Building Product Models*



Bim Team:

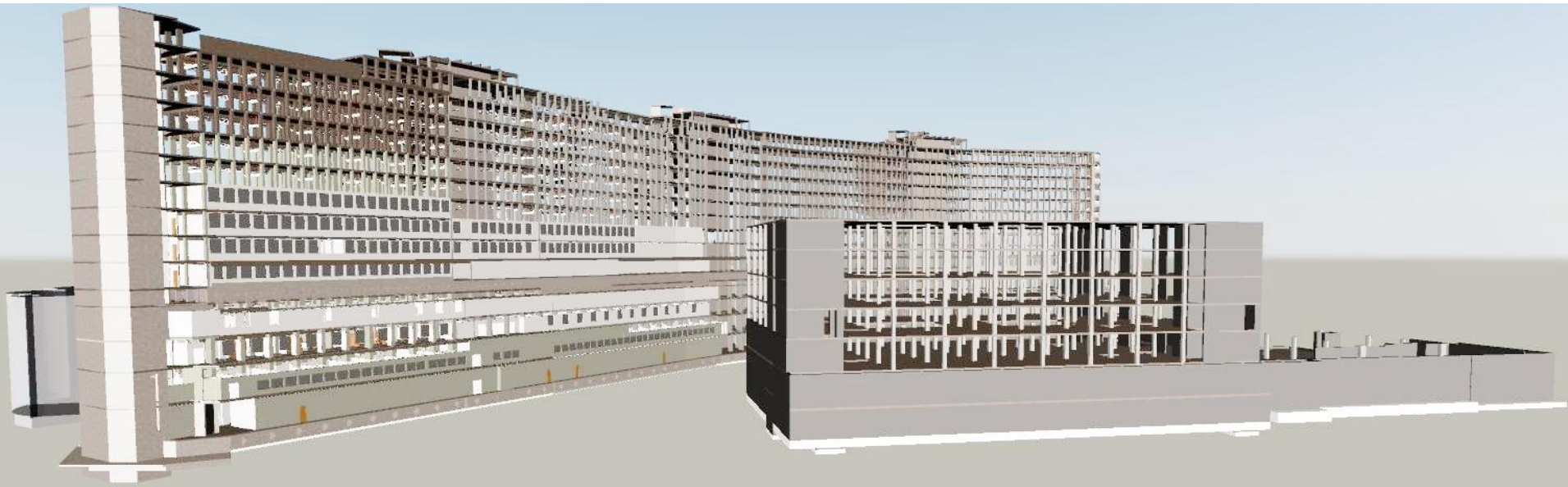
BIM manager: 1 person
BIM coordinators: 3 people
BIM modeler: 12 people
BIM validator: 1 person

Building Cost:

160.000.000 €

FM contract:

4 time construction cost





Case history: CMB BIM pilot project

CMB is one of the largest construction companies in the Italian market, working both in infrastructure and civil buildings (mainly hospitals). CMB has been active in construction since 1908.

In recent years the CMB business has moved from simple construction contracts, both public and private, to more complex forms of contracts, like P and Concession contract. Since 2000, CMB has become more and more involved in the design, construction and facility management processes. CMB's interest in the whole supply chain of design, construction and facility management processes had continued to grow substantially and in 2012 the management of the company decided to measure the impact of BIM starting a collaboration with the University of Brescia and some of the most important software companies involved BIM.

During 2012 CMB developed a series of tests for field BIM and laser scanning and developed parts of 3D models based on projects managed in the traditional way. At the end of 2012 CMB decided to start its "pilot" project testing some of the main aspects of BIM implementation within the management of a hospital project: CMB BIM Pilot Project. CMB decided to start the pilot project as a "parallel activity", and continued to use the traditional methods for the real management of the project with the aim of trying to make comparisons between the traditional and BIM methods.

The CMB BIM Pilot Project is based on a Hospital Refurbishment and Extension Project: the San Gerardo Hospital in Monza, close to Milan.

CMB BIM Pilot Project is almost at the end of its first phase (120 days) with a lot of interesting results coming from the tests developed. These results include the construction of the 3D model, quantity take off, coordination of designs, development of 2D deliverables and model checking.

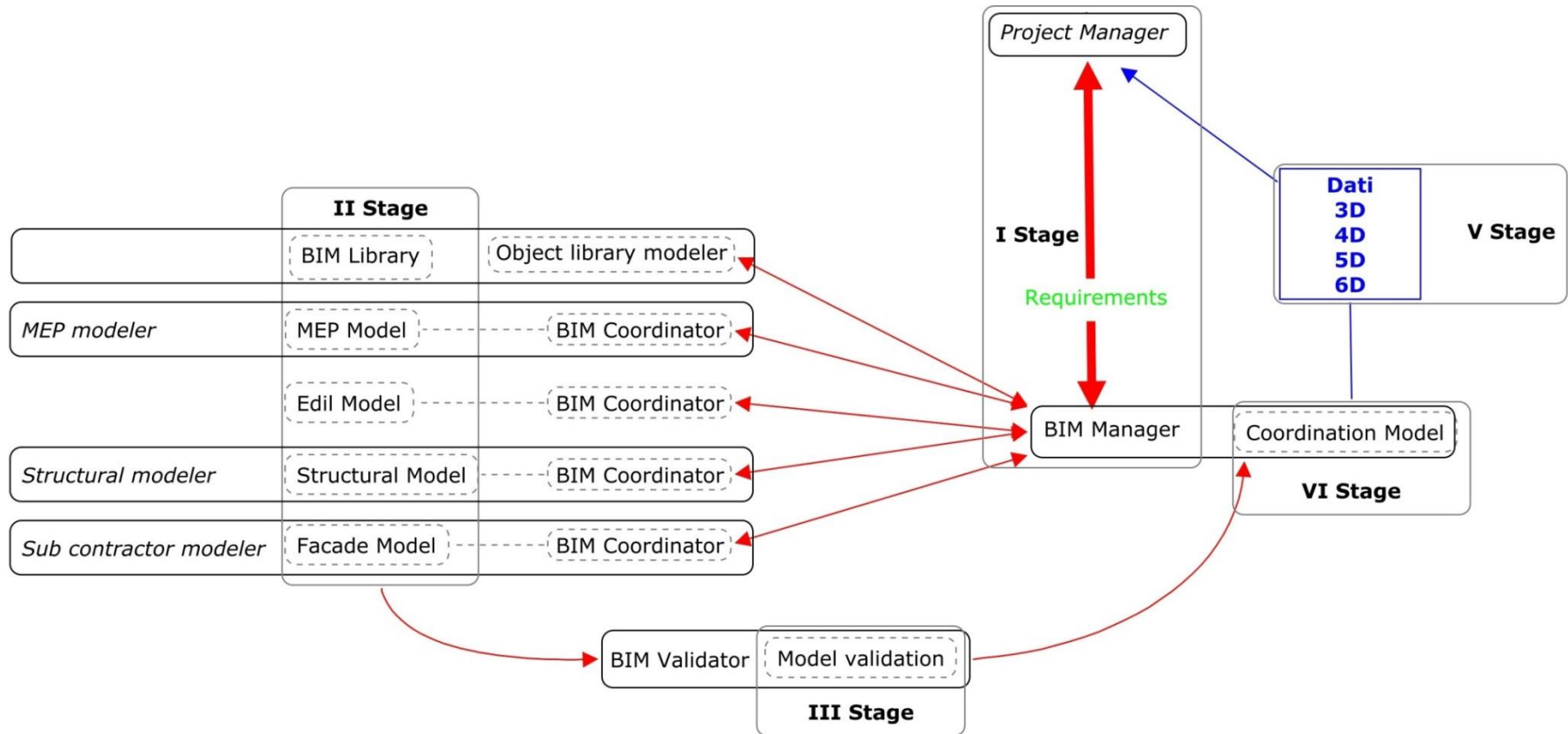
Among other software tested and utilized in the pilot project, and thanks to the collaboration with the University of Brescia, CMB decided to test Solibri's product for model checking and code checking, in order to measure a series of benchmarks in the Design Validation process. Providing an optimized and well

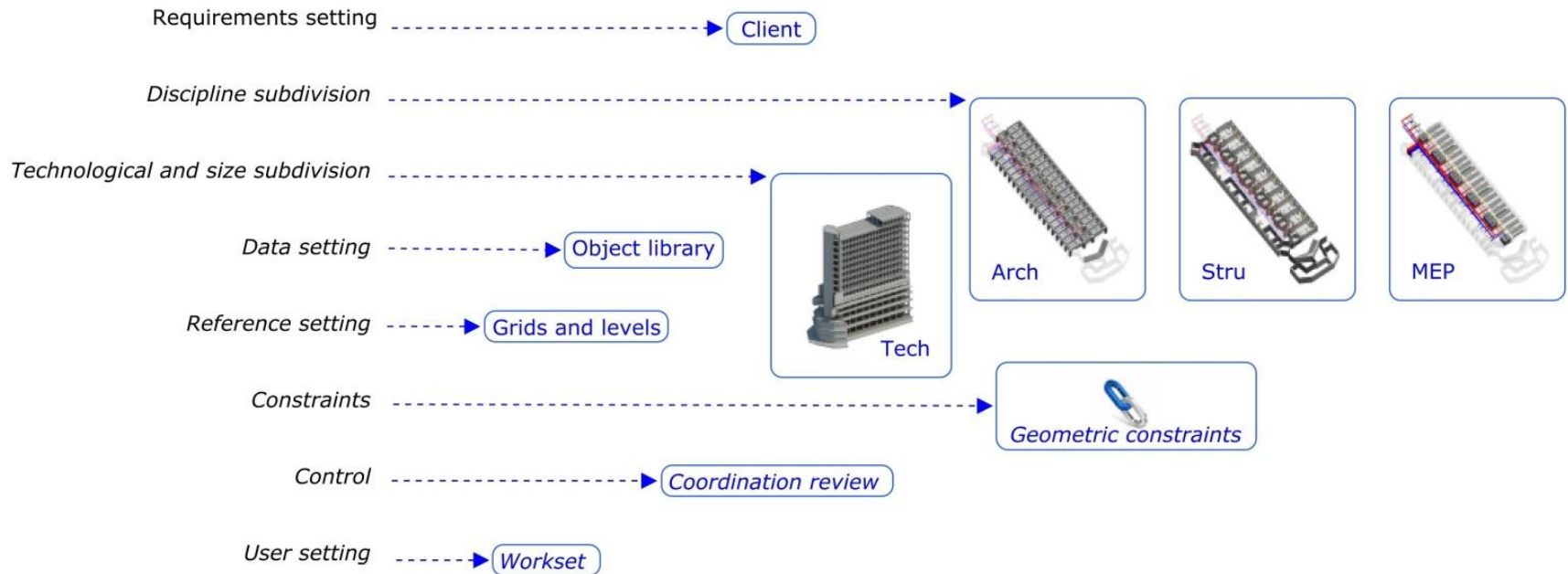
coordinated design has been one of the main goals of the CMB BIM Project.

CMB is currently analyzing the results but the management of the company is already scheduling improvements to its processes and the

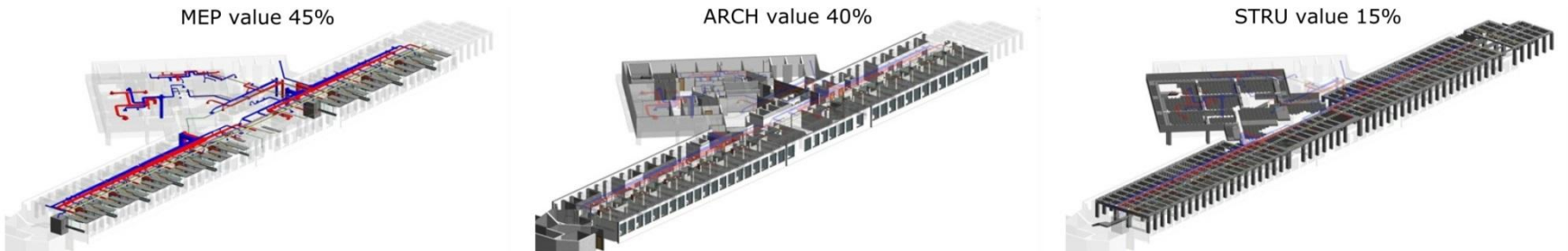


June 2013, Analysis of circulation for a wheelchair

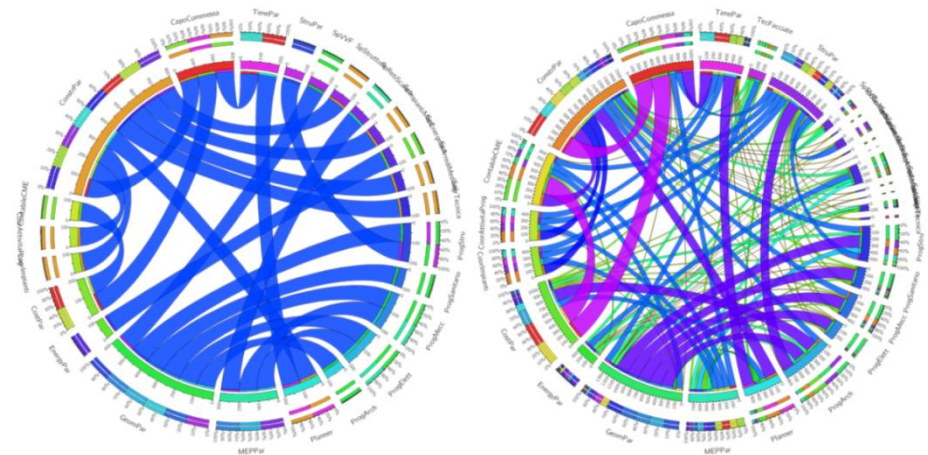
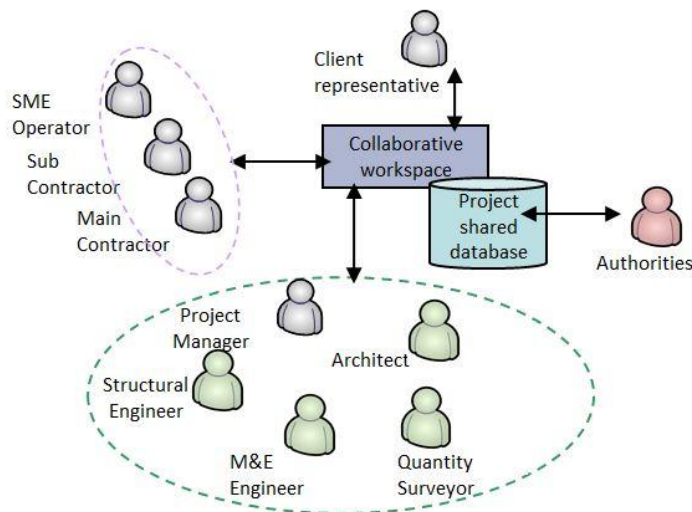
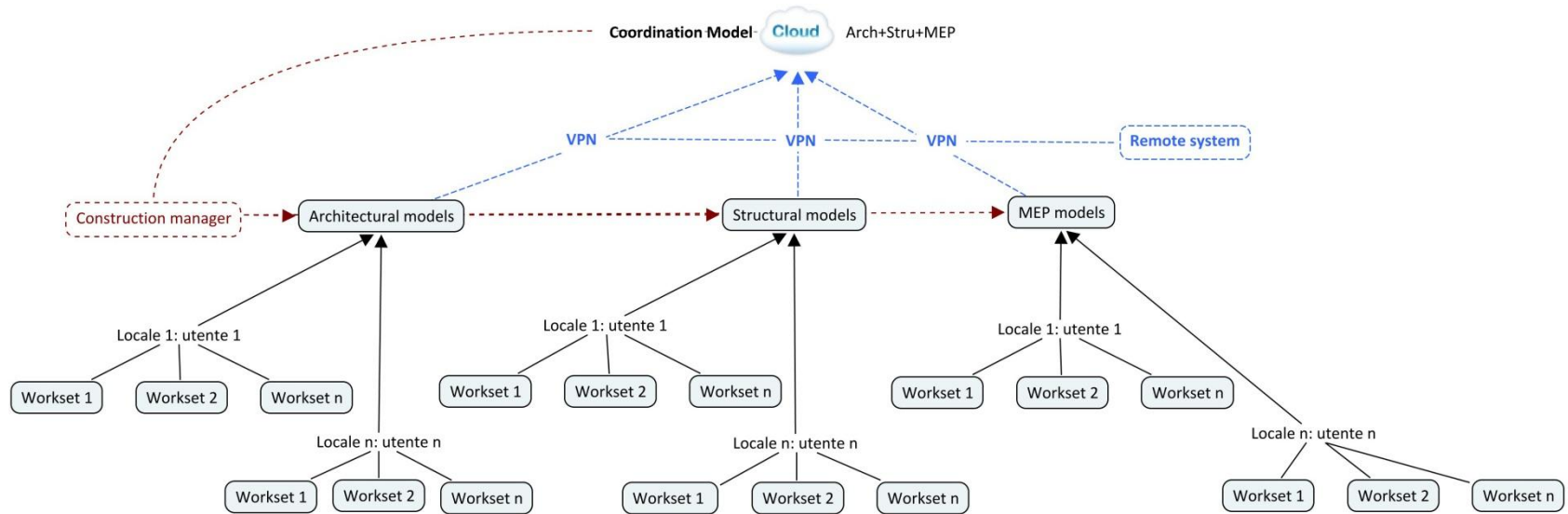




BIM *model setting*



BIM model divided by discipline and economic value

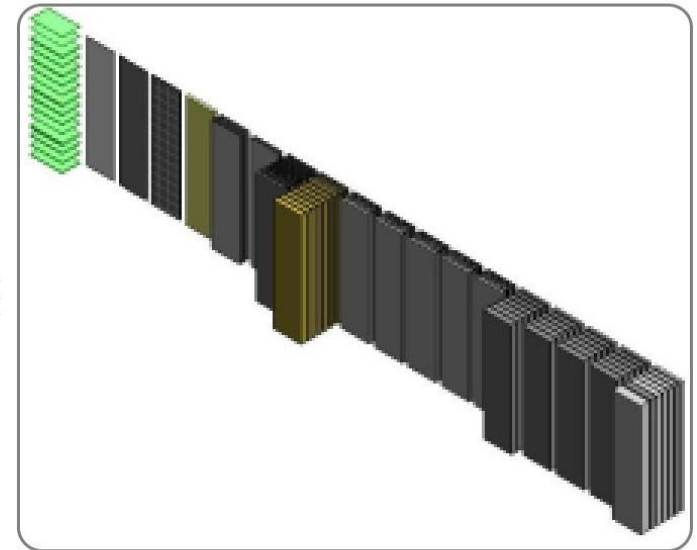


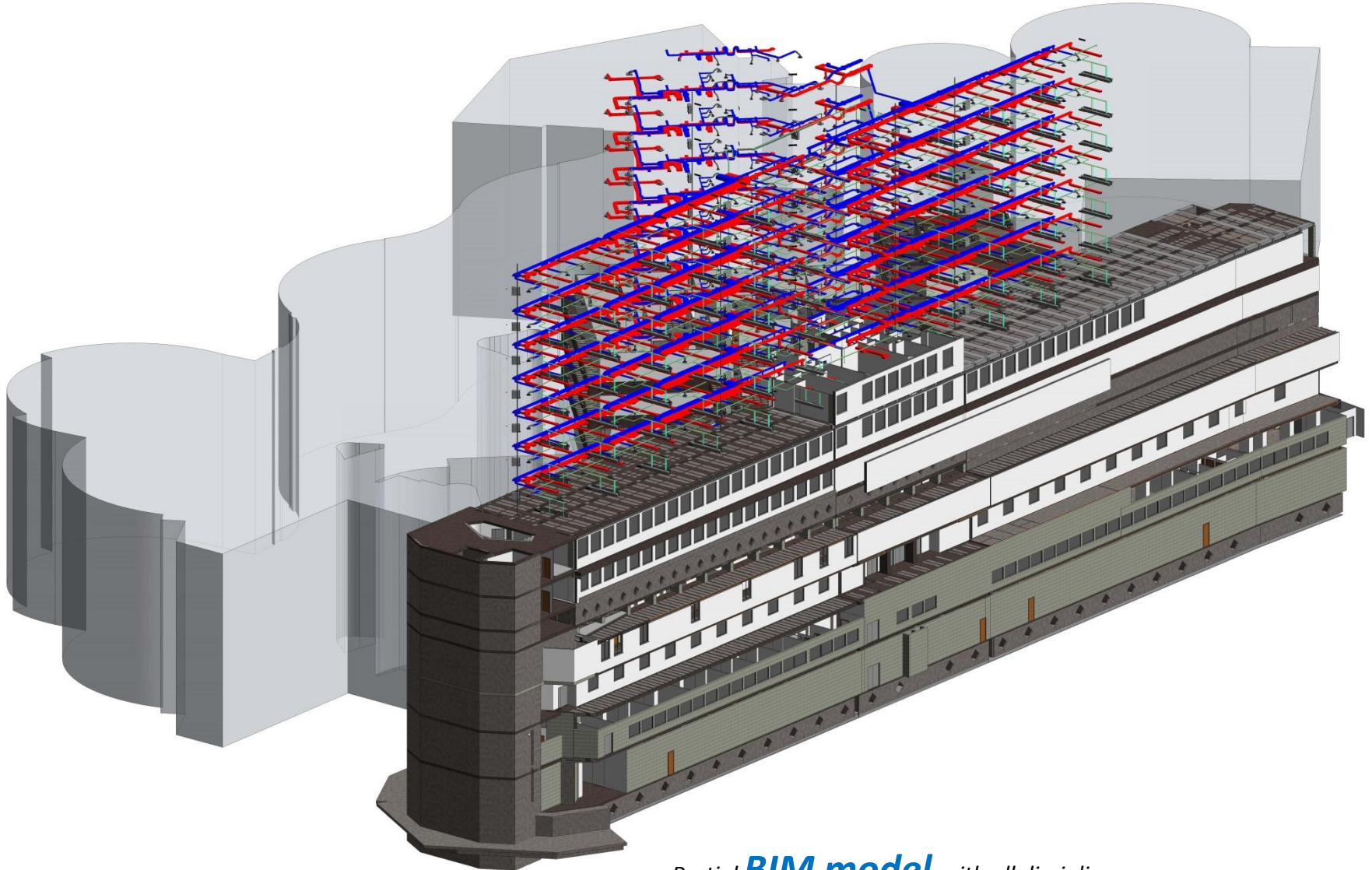
6D informations

product data and details
maintenance/operation manuals
cut sheet specifications
photos
warranty data
web links to product online sources
manufacturer information and contacts
etc.



Room references
such as room name, number
space type connected with asset information
such as manufacturer
model numbers
serial numbers
any operations and maintenance requirements





Partial **BIM model** with all disciplines

Bim & Structure:

Buildings' frames are made of structures that support buildings.

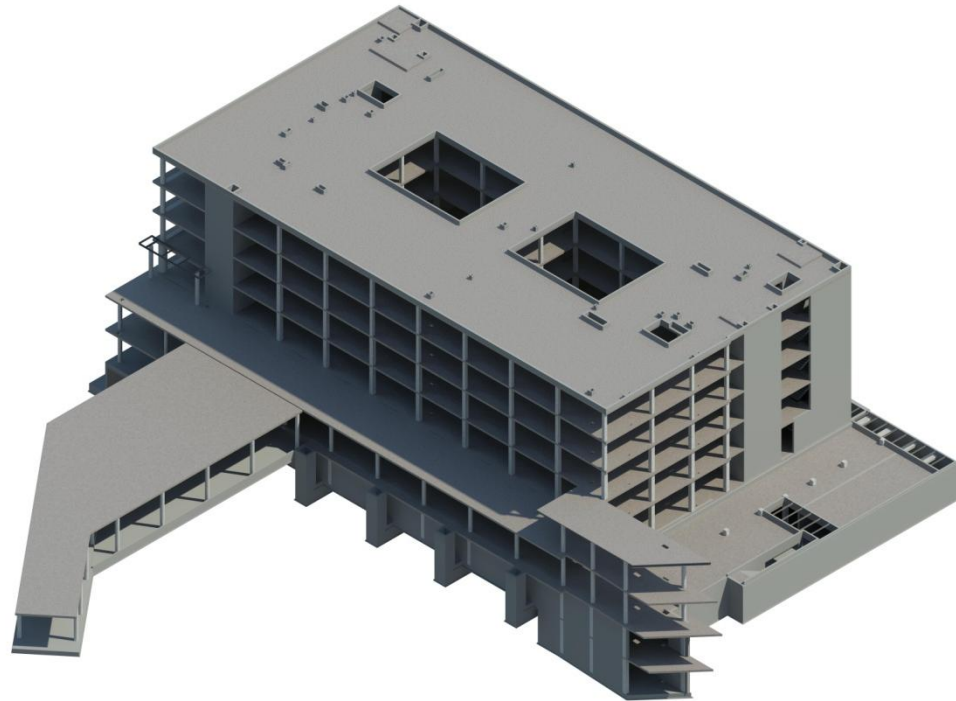
Previously structures were not externally visible, but they are actually part of architectural elements that strongly characterize the shape.

Italian law provides the definition of geometric parameters and structural requirements to ensure proper features and durability of buildings.



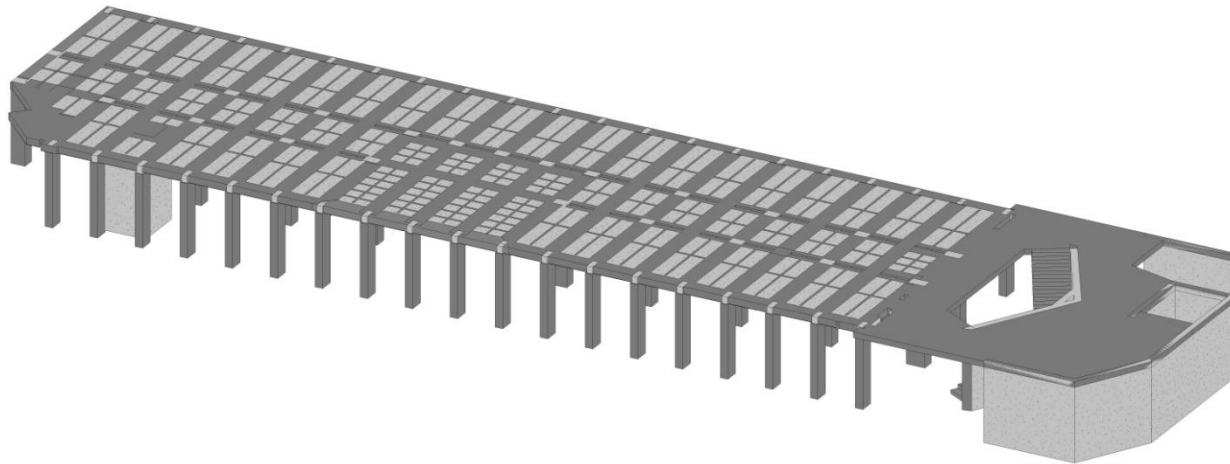
Bim & Structure:

The definition of structural and mechanical properties of materials plays a decisive role in the field of structural design (ex.: the section of the structural elements directly dependent to the capacity of resistance). This conditions is true in the case of a reinforced concrete, but also in the case of steel, where high strength parameters may allow a significant sectional reduction.



Bim & Structure:

The design specialist have to make an appropriate mix-design of the material, not only for the structural analysis but also related to facilities. It's clear that today the design of the BIM structural part is very important, not only for structural engineer but also for the technical specialists affected by the problems related to the streamlining of structural elements.



Actual Project:

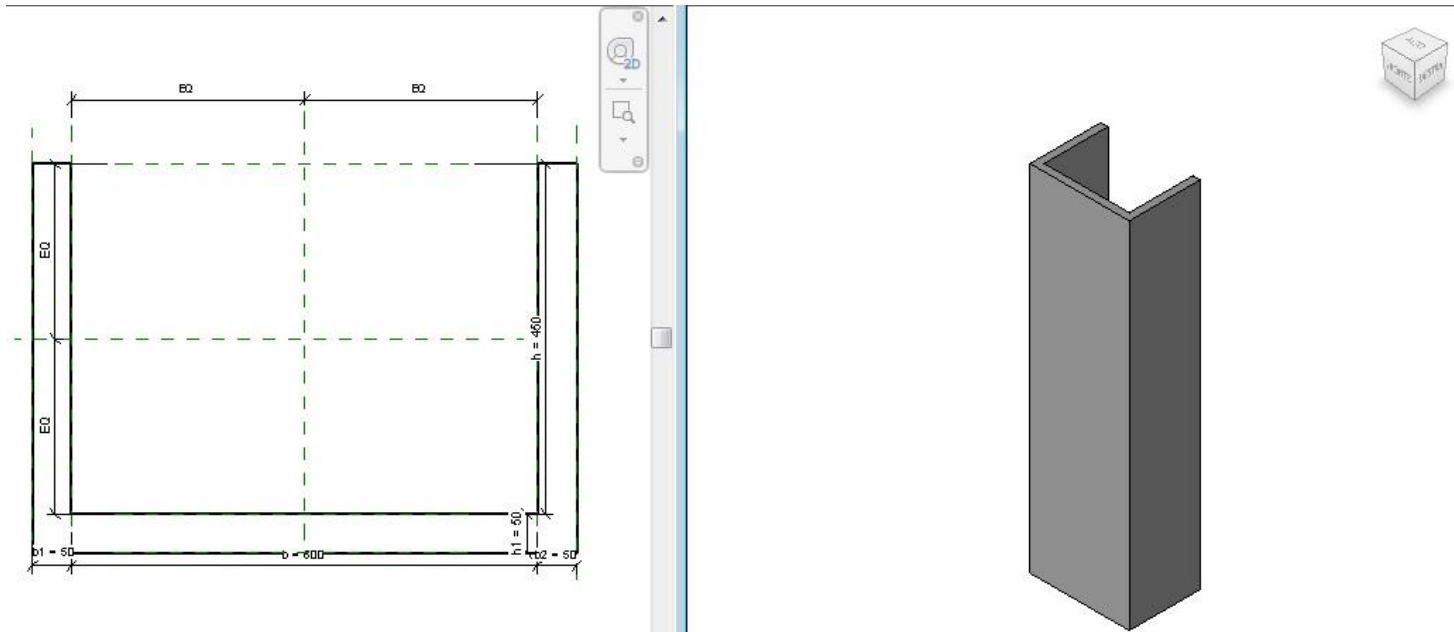
In the main cases analyzed, refurbishment and redevelopment of hospital, the ability to use informative parameters provide a competitive advantage for a proper modeling of the structural operation. It is possible to model the mechanical characteristics of the existing structures, uniquely identifying using the codes assigned to structural grids.

The definition of the family representative system of reinforcement element plays an important role because the unit cost of these interventions is high.

The ability to accurately estimate costs is critical in situation with repetitive actions such as reinforcing column. During the development of structural design, it was decided to analyze various solutions, including the winning solution to coating fiber-reinforced only on three sides; the structural change was immediately reported in modeling providing real-time variation of a quantity otherwise not easily obtainable.

Actual Project:

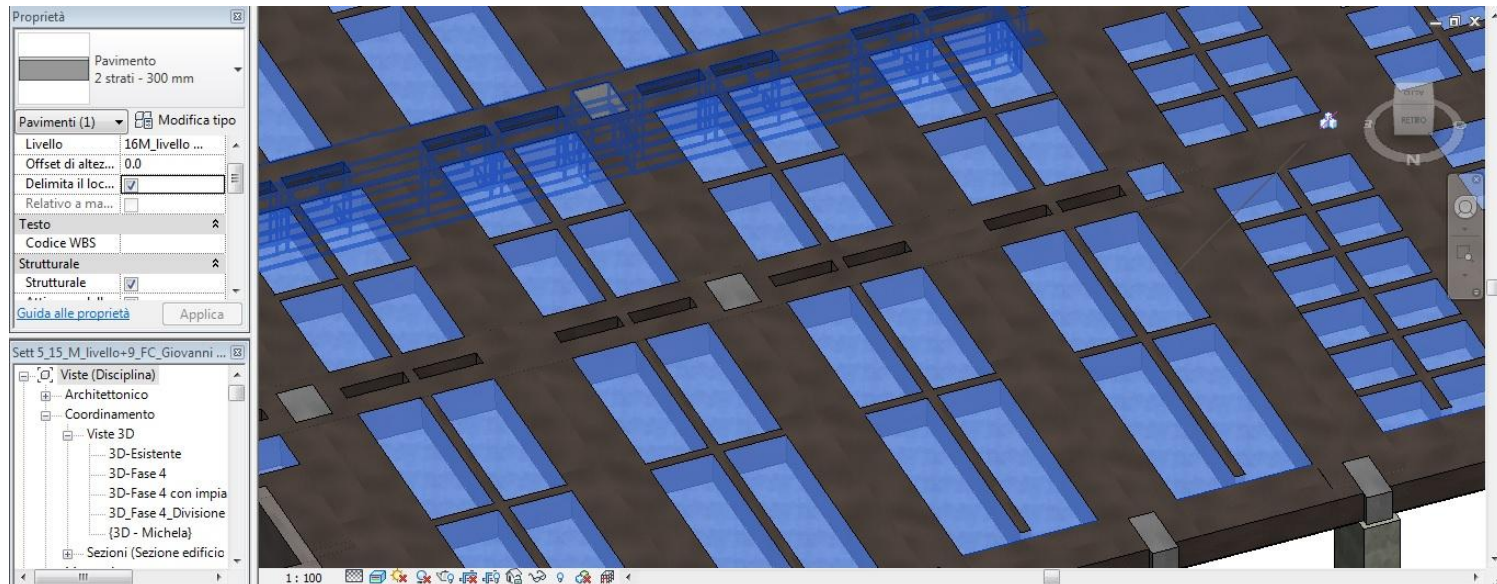
The ability to accurately estimate costs is critical in situation with repetitive actions such as reinforcing column. During the development of structural design, it was decided to analyze various solutions, including the winning solution to coating fiber-reinforced only on three sides; the structural change was immediately reported in modeling providing real-time variation of a quantity otherwise not easily obtainable.



Actual Project:

Similar importance was the choice of modeling the floor structures, differentiating the bearing elements from those of lightening giving, in this way, the interference's analysis, so the passage of plant systems is optimized.

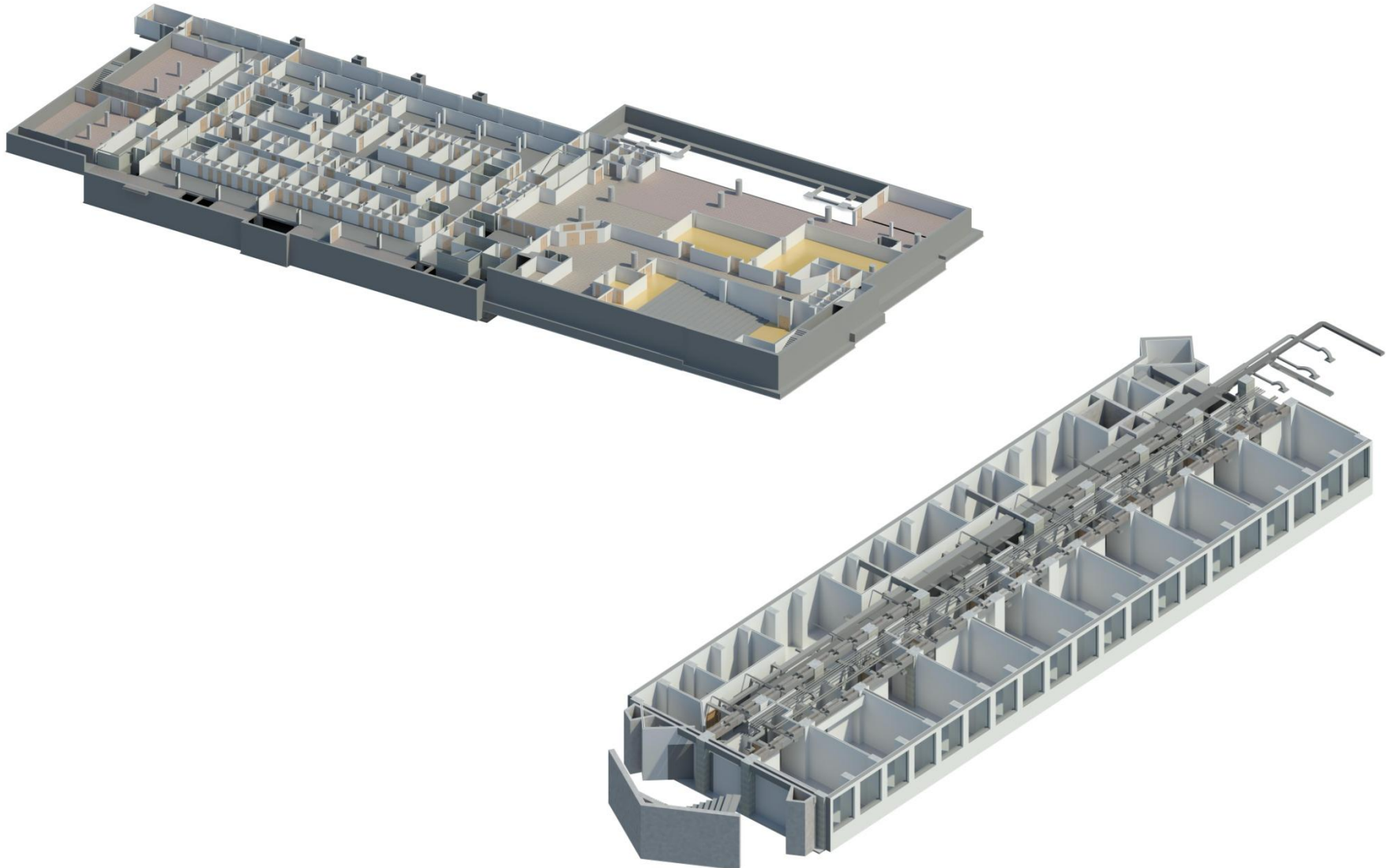
In hospital project there is a new building that will most likely be made with partially prefabricated elements in order to speed up the process of construction.



Criticality and Potential Development:

In fact the tendency to change a site area of building in an assembly environment is very strong and is leading to consequences for the de-structuring entire supply chain. This process of transformation would be in a BIM oriented way as a valuable planning tool for the deconstruction into objects assembled, condition that requires a strong analysis of the entire design process - implementation - transport and installation, compared to a standardization of the process. Such an approach in the field of BIM lead to the creation of families with structured within all the information relating to needs of transport (bulk, articulated trucks to use, labor and installation time...), installation (lifting procedures, regulation of connections...) and structural behavior (type of constraints ...).

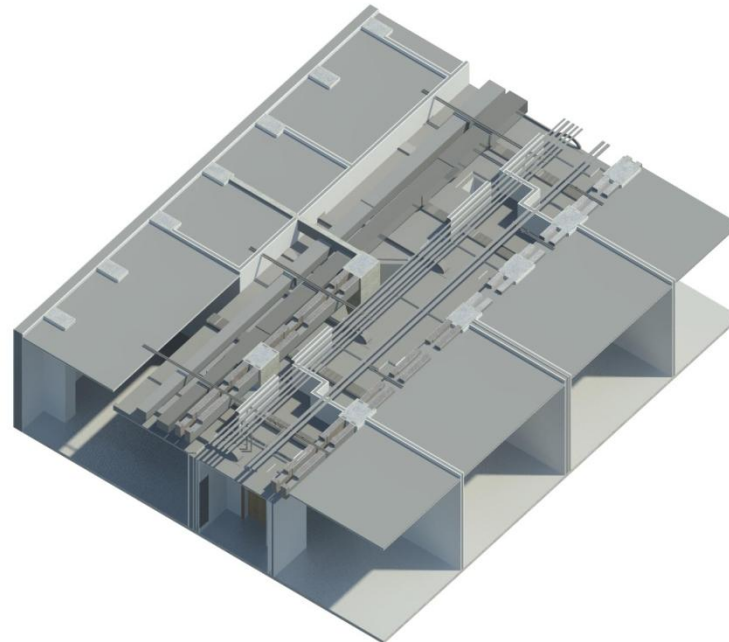




Partial **BIM model** with all disciplines

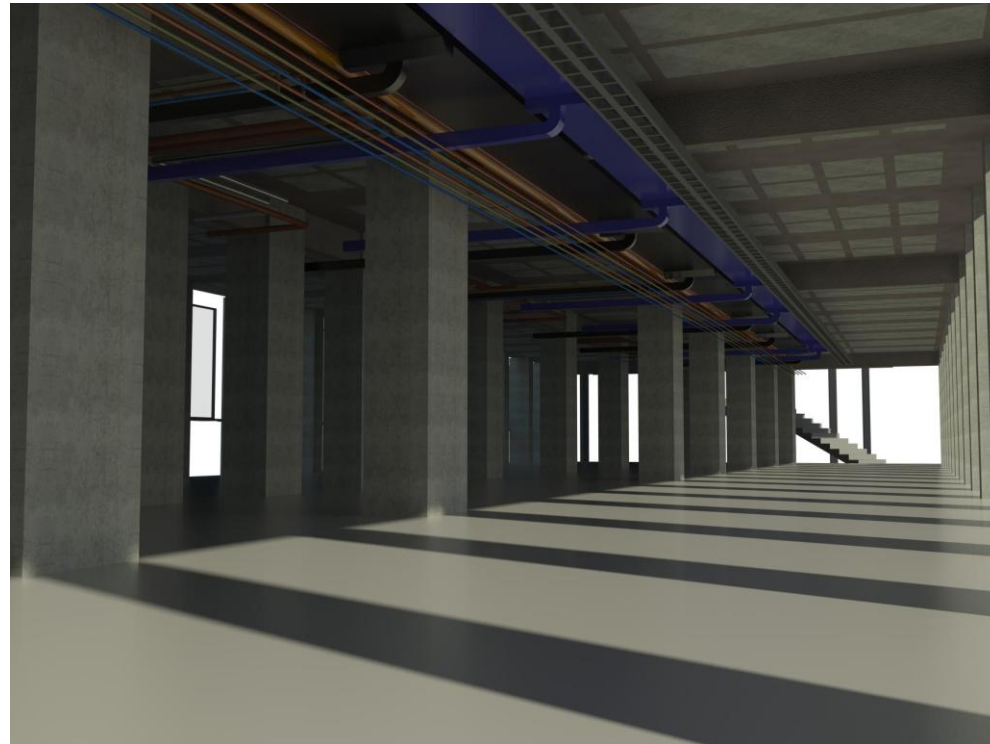
Criticality and Potential Development:

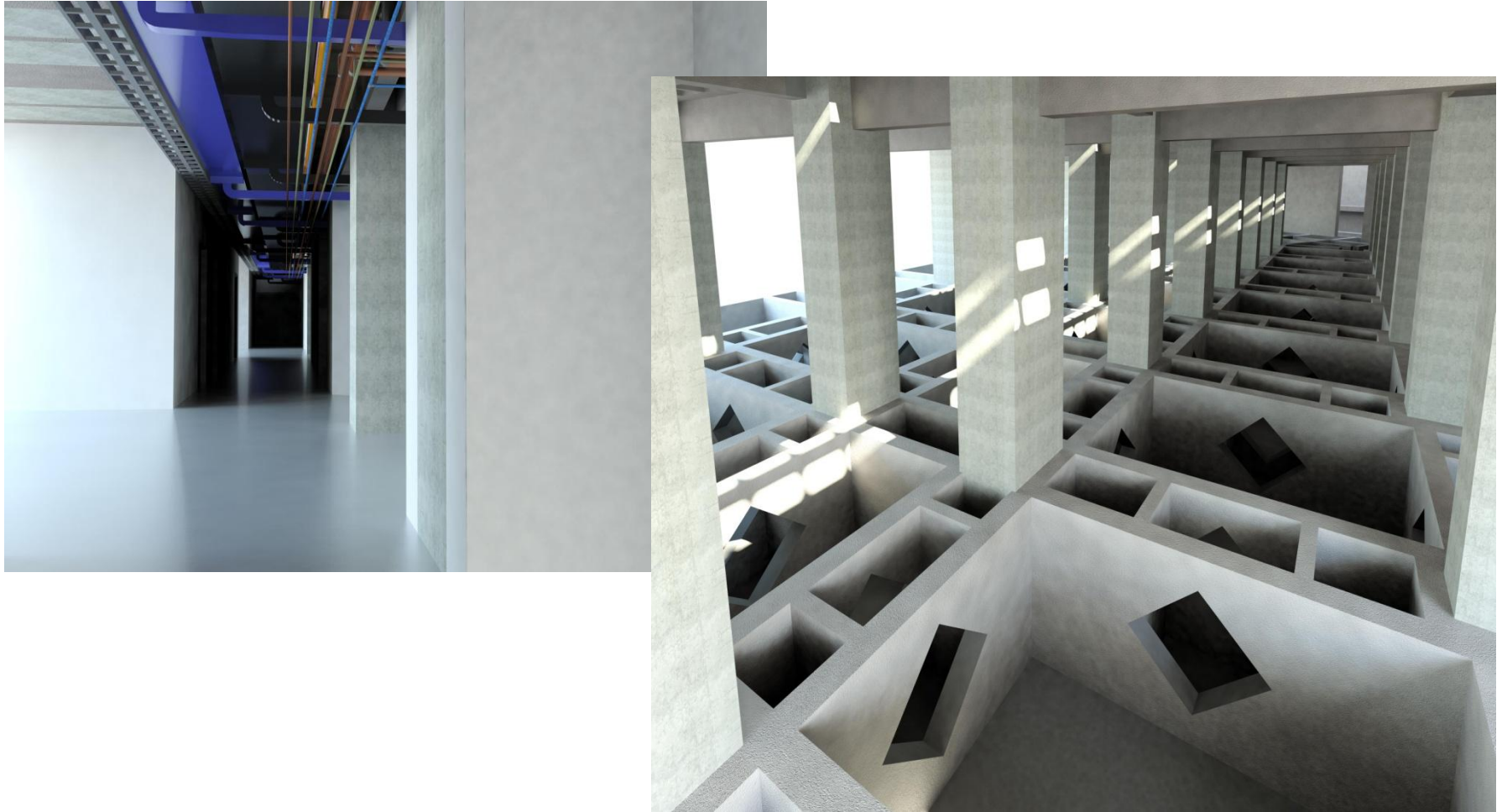
Finally, the Italian law requires the production of manual management of manufactured in which they must be described the way of action on non-structural but also must provide a "timetable" of the checks on the structural parts. This information can be incorporated into an intelligent BIM objects that contain some information and date fields to allow export of a maintenance plan maybe importable and relatable with the calendar system. In this way we can have a bidirectional diary management of whole building manufacturing.

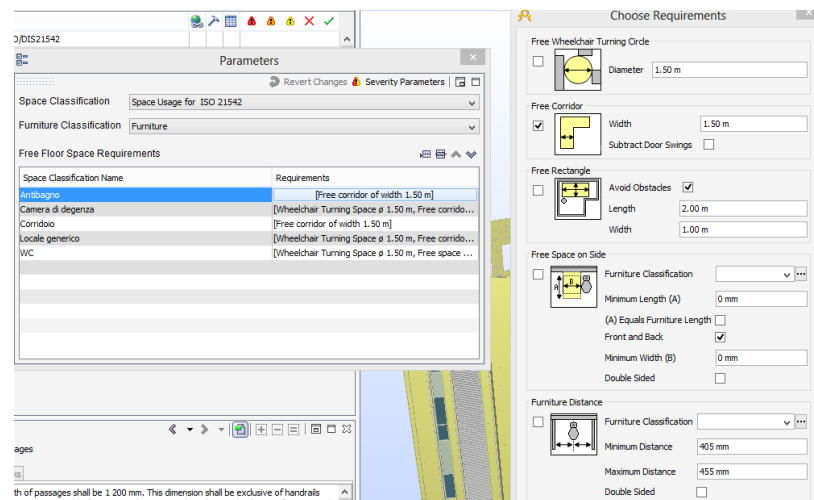
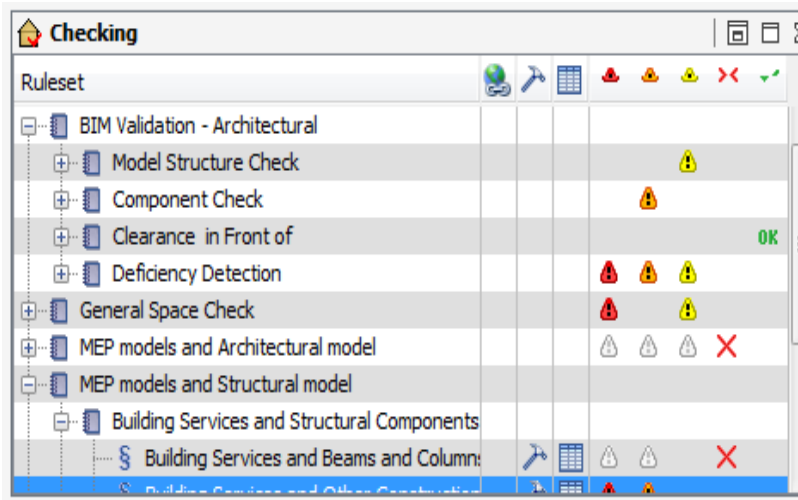


Criticality and Potential Development:

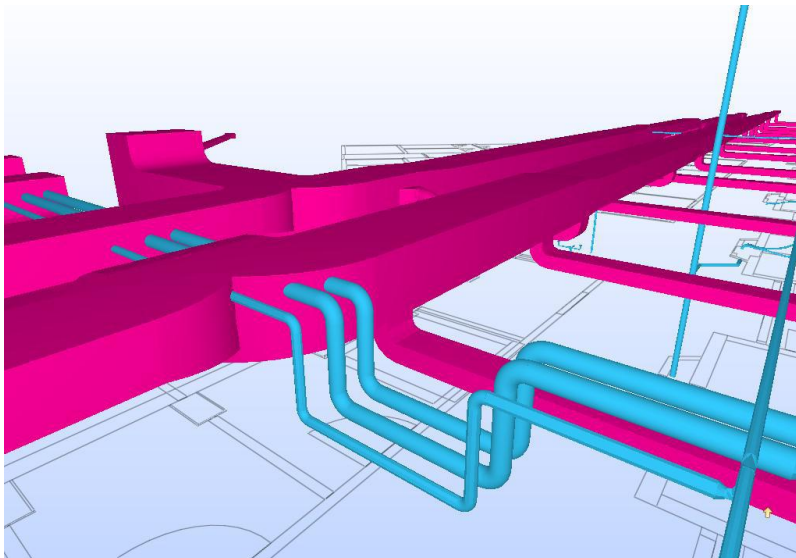
Moreover the building structures are designed with an average life cycle of 50 years, and duration of building is much higher. From this directly follows the need for the future, to retrain structurally artifacts of which we know few. The creation of a BIM model would be an important step in the formation of a database of buildings that would allow a complete knowledge. The Building Information Modeling in structural design would be a strong stimulus to the full application of this approach to the entire sector and supply chain, achieving economic advantages and system.







Solibri BIM validation

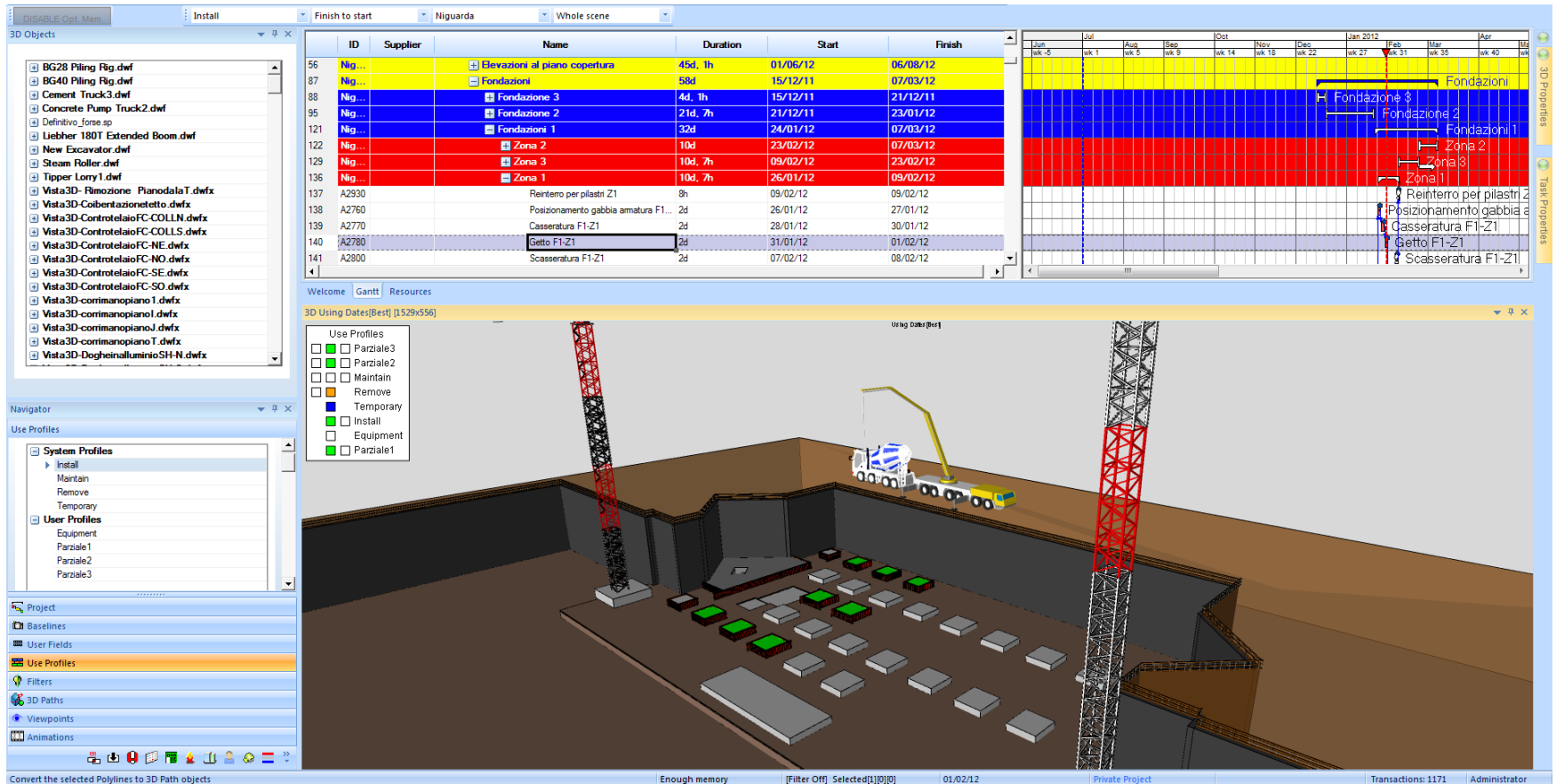


Clash detection



Code checking

Model checking



OC.B7.5039	PARETI DIVISORIE IN CARTONGESSO Parete divisoria in lastre di cartongesso dello spessore di 12,5 mm fissate mediante viti autoavvitanti ad una struttura costituita da profilati in lamiera di acciaio zincato da 0,6 mm con montanti ad interasse di 600 mm e guide al pavimento e soffitto fissate alle strutture, compresa la formazione degli spigoli vivi, retratti o sporgenti, la stuccatura dei giunti e la sigillatura all'incontro con il soffitto con nastro vinilico monoadesivo e la formazione di eventuali vanti porta e vanti finestra, con i contorni dotati di profilati metallici per il fissaggio dei serramenti	m²	30,99	34,00
OC.B7.5039/b	con due lastre di cartongesso su entrambi i lati della parete (Euro trentaquattro/85)			

IC.09.070.0000/b	con montanti e guide fissate a pavimento e a soffitto e da lastre in silicato di calcio a matrice cementizia accoppiate con viti e fissate all'orditura metallica, compresi piani di lavoro interni, sigillatura dei giunti e stuccatura - REI 120, con tre lastre spessore 15 + 15 + 15 mm (Euro centouno/97)	m²	30,99	34,00
------------------	--	----	-------	-------

IC.10.500.0000/b	- 20 mm (Euro quattro/33)	m²	60,02	4,00
IC.10.500.0000/b	- per ogni 10 mm in più (Euro uno/31)	m² x cm	10,00	1,01

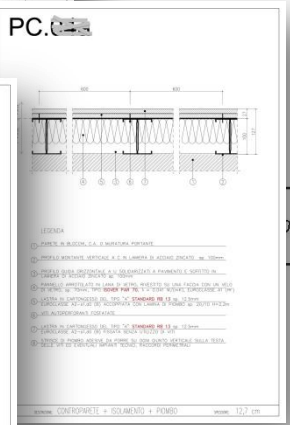
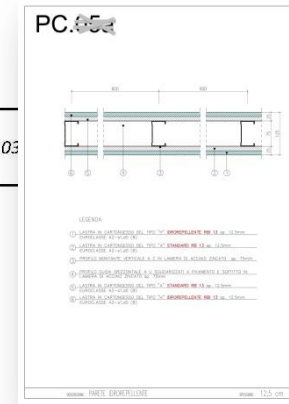
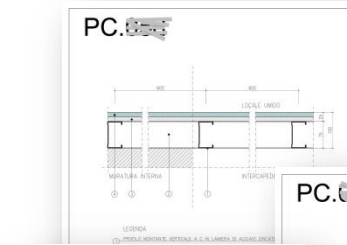
TIPO PC. / CODICI ARTICOLI	1C.09.070.0000/b	6/10 con montanti e guide fissate a pavimento e a soffitto, da due lastre in silicato di calcio a matrice cementizia accoppiate con viti e fissate all'orditura metallica e da materassino in lana di roccia densità 60 kg/m³, compresi piani di lavoro interni, sigillatura dei giunti e stuccatura - REI 120, con due lastre per lato ed isolate, spess. 10+12+100+10+12 mm	m²	00,10	100,10	070.0030	PA.ED.001.a	PA.ED.003
----------------------------	------------------	--	----	-------	--------	----------	-------------	-----------

PC.01	1C.06.550.0000	Cartongesso realizzata con lastre in gesso rivestito a bordi assottigliati, spessore 13 mm ed interposta armatura in profilati acciaio zincati da 6/10 per guide a pavimento e a soffitto e per montanti ad interasse di 60 cm, compresa la restura dei giunti, i piani di lavoro interni e l'esecuzione muraria dell'impresa (Euro trentadue/48)	m²	00,00	30,00
-------	----------------	--	----	-------	-------

PC.02	PA.ED.001/a	con due lastre di cartongesso su entrambi i lati della parete di cui una accoppiata a lamina in piombo spessore mm 2 (Euro centoquarantadue/00)	m²	40,40	140,00
-------	-------------	--	----	-------	--------

PC.03					
PC.03 per cavedi					
PC.03a					
PC.04					
PC.04a					
PC.04a + PC.03					
PC.04b					
PC.05					
PC.05a					
PC.05b					
PC.05c					
PC.05d					
PC.06a					
PC.06b					
PC.06c	X				

PC.07					
PC.07a					
PC.08					
PC.10					
PC.11					
PC.11a					
X					
X					



Browser dei materiali - Pannello murario in gesso_A_A2

Materiali nel documento: tutti

Nome
Muro di default
nbl_PlasterboardGypsum
Pannello murario in gesso
Pannello murario in gesso_A_A2
Pannello murario in gesso_A_A2.b
Pannello murario in gesso_A_A2.c
Pannello murario in gesso_A_A2_NO

Materiali Autodesk

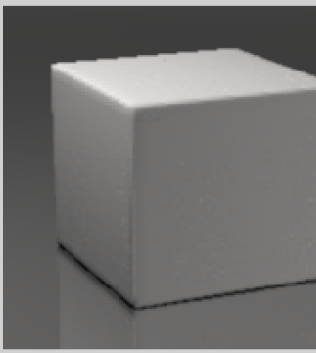
Preferiti

Materiali Autodesk

Materiali AEC

Per categoria

Editor dei materiali



Pannello murario in gesso_A_A2

Risorse

Nome	Aspetto
Pannello murario in gesso_A_A2	Grafica
Cartongesso - Vernice bianca(1)	Aspetto
Pannello murario in gesso(1)	Fisico
Cartongesso(1)	Termico

Grafica Proprietà

Ombreggiatura

Utilizza composizione

Parametri personalizzati

Parametri materiale

Parametro	Valore
Testo	
Codice Articolo STR	
Euroclasse	A2
Tipo	A
Cod. Fase	PDE
Cod. Area	E02
Cod. Categoria	EDI
Cod. Sottocategoria	MUI
Cod. Blocco	MOA
Prg.	
Articolo	OC.B7.5039.b
CodiceArticolo	OC.B7.5039.b
Codici 2	
Dimensioni	
Passo montanti	
Parametri IFC	
NBSVersion	
RevitMaterial	
Dati	
Passo montanti materi	
Altro	
Prezzo unitario	20.00

OK Annulla

Modifica abaco/quantità

Proprietà

Abaco Schedule

Abaco: 2 - Prezzi

Modifica tipo

Dati identità

Modello vista <Nessuno>

Nome vista 2 - Prezzi Artico...

Dipendenza Indipendente

Fasi

Filtro delle fasi Show All

Fase Phase 3

Altro

Campi Modifica...

Filtro Modifica...

Guida alle proprietà

Applica

Browser di progetto - Abaco PC-corr...

Level 2

Site

Piante dei controsoffitti (Ceili

Viste 3D (3D View)

Legende

Abachi/Quantità

1 - Costi PC

2 - Prezzi Articoli

2 - Prezzi Articoli 2

Area Schedule (Gross Building

Casework Quantities

Ceiling Quantities by Type

Door Quantities
















Electrical Equipment Quanti

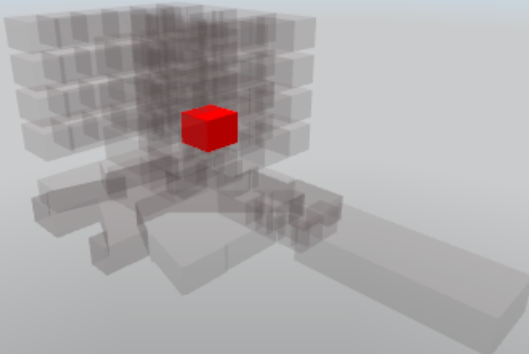
Electrical Fixture Quantities

Floor Quantities by Assembl













<2 - Prezzi Articoli 2>

A	B	C	D	E	F	G	H	I	J	K	L	M
Piano	Cod. Area	Cod. Blocco	Cod. Cat	Cod. Fase	Tipo parete	Costo unitario/m²	Codice Articolo	Cod. Sott	Materiale	Area materiale	Prezzo unitario/m²	Prezzo totale
1*	E02	MOA	EDI	PDE	PC.01		OC.B7.5039.b	MUI	Pannello murario in gesso_A_A2	1 m²		
1*	E02	MOA	EDI	PDE	PC.02		OC.B7.5039.b	MUI	Pannello murario in gesso_A_A2	1 m²		
1*	E02	MOA	EDI	PDE	PC.02		1C.10.500.0040.a	ISO	Lana di vetro	1 m²		
1*	E02	MOA	EDI	PDE	PC.02		1C.10.500.0040.b	ISO	Lana di vetro(1)	1 m²		
1*	E02	MOA	EDI	PDE	PC.02		1C.10.500.0040.b	ISO	Lana di vetro(2)	1 m²		
1*	E02	MOA	EDI	PDE	PC.02		1C.10.500.0040.b	ISO	Lana di vetro(3)	1 m²		
1*	E02	MOA	EDI	PDE	PC.02		1C.10.500.0040.b	ISO	Lana di vetro(4)	1 m²		
1*	E02	MOA	EDI	PDE	PC.02		1C.10.500.0040.b	ISO	Lana di vetro(5)	1 m²		
1*	E02	MOA	EDI	PDE	PC.03		1C.09.070.0030.d	MUI	Pannello murario in gesso_F_A2	1 m²		
1*	E02	MOA	EDI	PDE	PC.04		1C.10.500.0040.a	ISO	Lana di vetro	1 m²		
1*	E02	MOA	EDI	PDE	PC.04		PA.ED.001.a	MUI	Pannello murario in gesso_A_A2+piombo	1 m²		
1*	E02	MOA	EDI	PDE	PC.04		1C.10.500.0040.b	ISO	Lana di vetro(1)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04		1C.10.500.0040.b	ISO	Lana di vetro(2)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04		1C.10.500.0040.b	ISO	Lana di vetro(3)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04		1C.10.500.0040.b	ISO	Lana di vetro(4)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04		1C.10.500.0040.b	ISO	Lana di vetro(5)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a		1C.10.500.0040.a	ISO	Lana di vetro	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a		PA.ED.001.a	MUI	Pannello murario in gesso_A_A2+piombo	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a		1C.10.500.0040.b	ISO	Lana di vetro(1)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a		1C.10.500.0040.b	ISO	Lana di vetro(2)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a		1C.10.500.0040.b	ISO	Lana di vetro(3)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a		1C.10.500.0040.b	ISO	Lana di vetro(4)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a		1C.10.500.0040.b	ISO	Lana di vetro(5)	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a +		1C.09.070.0030.d	MUI	Pannello murario in gesso_F_A2	1 m²		
1*	E02	MOA	EDI	PDE	PC.04a +		PA.ED.001.a	MUI	Pannello murario in gesso_A_A2+piombo	1 m²		
1*	E02	MOA	EDI	PDE	PC.04b		PA.ED.001.a	MUI	Pannello murario in gesso_A_A2+piombo	1 m²		
1*	E02	MOA	EDI	PDE	PC.05		PA.ED.036.a	MUI	Pannello murario in gesso_H_A2	1 m²		
1*	E02	MOA	EDI	PDE	PC.05		1C.10.500.0040.a	ISO	Lana di vetro	1 m²		
1*	E02	MOA	EDI	PDE	PC.05		1C.10.500.0040.b	ISO	Lana di vetro(1)	1 m²		

Room Function #:	Room Number:	Name:	Prog. ...	Design...	RDS status	Equipment status	Covering status
 01.01.021	B 1-5	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.022	B 1-4	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.023	B 1-3	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.025	B 1-2	Camera, 1 posto letto	11.00	13.46	From RT.001	From RT.001	From RT.001
 01.01.026	B 2-13	Camera, 1 posto letto	11.00	13.46	From RT.001	From RT.001	From RT.001
 01.01.027	B 2-14	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.028	B 2-15	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.029	B 2-16	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.030	B 2-17	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.031	B 2-18	Camera, 1 posto letto	11.00	13.46	From RT.001	From RT.001	From RT.001
 01.01.032	B 2-7	Camera, 1 posto letto	11.00	13.46	From RT.001	From RT.001	From RT.001
 01.01.033	B 2-6	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.034	B 2-5	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.035	B 2-4	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
 01.01.036	B 2-3	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001



Room Equipment list: 0101.032 / B 2-7 - Camera, 1 posto letto (From RT.001)

Preview	Revit	dRofus	Actions
	Arredi: Scrivania da studio 800 x 1200 x 600 mm Model Count: 1	0101.01.012 Scrivania 120x80 Planned Count: 1	Select
	Arredi: Sedia da lavoro (1) 400 x 500 mm Model Count: 1	0102.02.001 Sedia ergonomica Planned Count: 1	Select
	Arredi: Armadio 600x120x190mm Model Count: 1	0103.03.001 Armadio modulo da 120x60x60 Planned Count: 1	Select
	Arredi: Comodino 45x45x55mm Model Count: 1	0103.04.002 Comodino - cassetiera 45x45 Planned Count: 1	Select
	Arredi: Appendi abiti a tre Tipo 5 Model Count: 1	0103.09.001 Appendiabiti da muro a tre posti Planned Count: 1	Select
	Arredi: Letto singolo 80x200mm Model Count: 1	0104.01.001 Letto singolo 80x200 Planned Count: 1	Select
	Arredi: Cestino Cestino Model Count: 1	0190.90.003 Cestino Planned Count: 1	Select
	Arredi: Lampada comodino Lampada comodino Model Count: 1	0448.02.002 Corpo illuminante da letto Planned Count: 1	Select
	Arredi: Lampada da tavolo Lampada da tavolo (1) Model Count: 1	0448.02.003 Corpo illuminante da scrivania Planned Count: 1	Select
	Arredi: Scaffale 600x600x600mm Model Count: 0	0103.01.002 Scaffale 80x25 Planned Count: 1	Link
	Arredi: Cassetiera 600x600x600mm Model Count: 1	0103.04.001 Cassetiera per biancheria 60x60x60 Planned Count: 1	Place
	Arredi: Tenda ignifuga Model Count: 1	0105.01.001 Tenda ignifuga Planned Count: 1	Link

Options... Update dRofus Update Revit Refresh Close

Family Type <-> dRofus FF&E

Unlinked FF&E from dRofus

Name	Number
01 - Forniture (14)	
Tavolo 80x80	0101.01.010
Tavolo 100x100	0101.01.011
Tavolino	0101.09.002
Sedia	0102.04.001
Sedia 45x50	0102.04.003
Sedia 60x60	0102.04.004

Search:

Unlinked Family Symbols from Revit

Arredi (10)

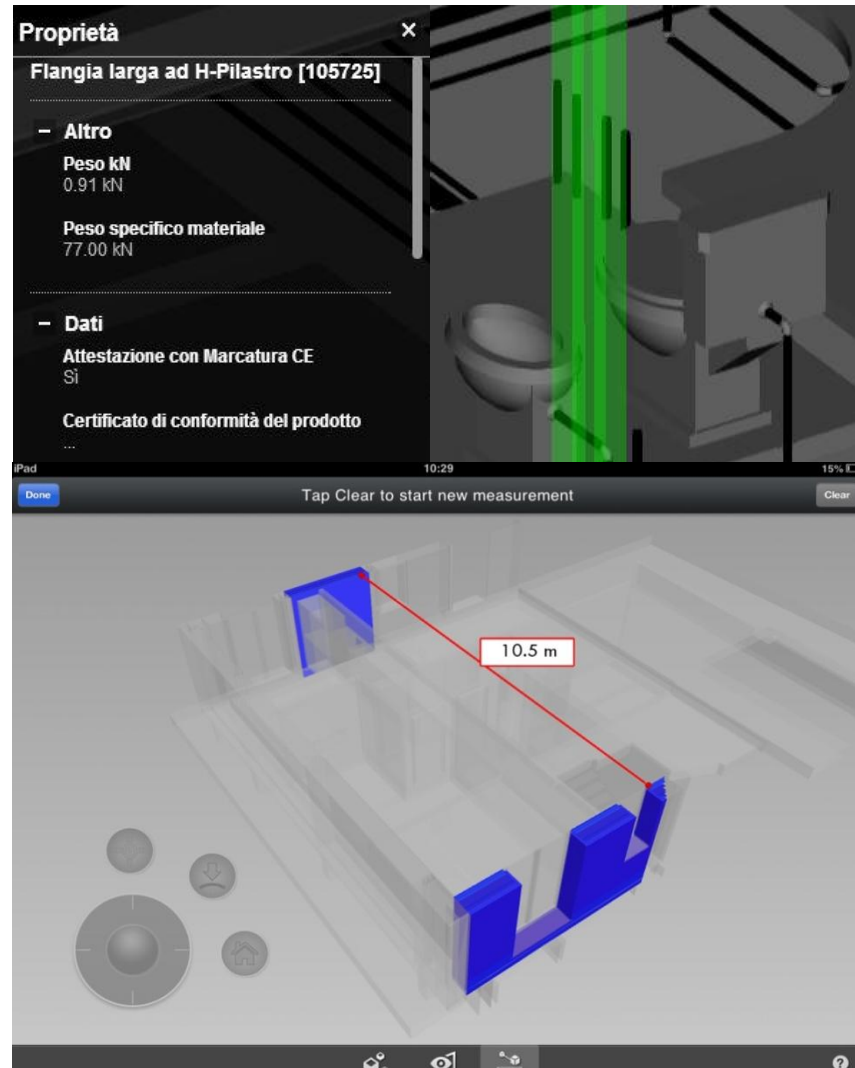
- Appendiabiti a piantana
- Appendiabiti a piantana
- Base - Porta singola
600 X 600 X 900 mm
- Doccetta con flessibile
Z7500-DV-HW

Linked FF&E

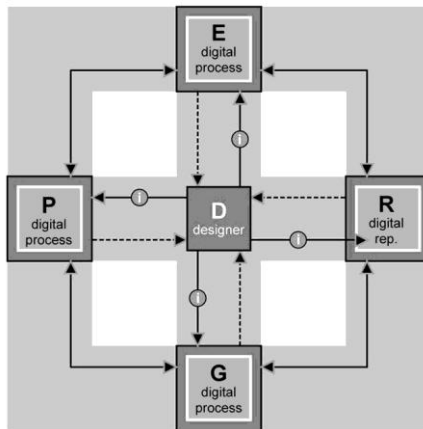
FF&E number	FF&E name	Category	Family	Name
0101.01.004	Tavolo da studio 270	Arredi	Scrivania da studio 1	2700 x 1200 x 600
0101.01.005	Scrivania 140x65	Arredi	Scrivania da studio 1	1400 x 650 x 600 mm
0101.01.006	Scrivania 170x65	Arredi	Scrivania da studio 1	1700 x 650 x 600 mm
0101.01.007	Scrivania 280x105	Arredi	Scrivania da studio 1	2800 x 1050 mm
0101.01.008	Scrivania 240x65	Arredi	Scrivania da studio 1	2400 x 650 x 600 mm
0101.01.009	Tavolo da studio 180	Arredi	Scrivania da studio 1	1800 x 1200 x 600 mm
0101.01.012	Scrivania 120x80	Arredi	Scrivania da studio 1	800 x 1200 x 600 mm
0101.02.001	Tavolo da riunione 3	Arredi	Tavolo riunioni	2400 x 1200 mm

Using configuration: Default Categories

Unlink Sync Sync all Close



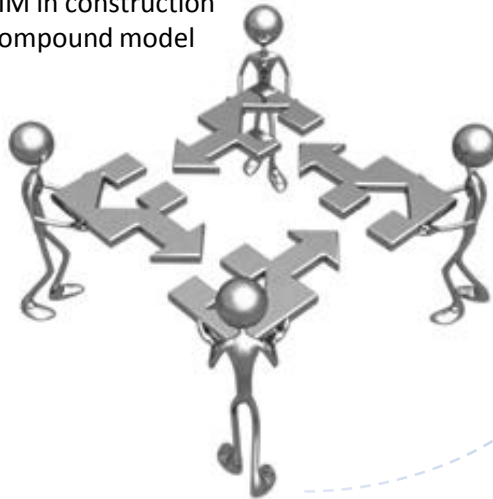
Data visualization in construction site based on BIM model (through **AR** device) and vice versa, communication from construction site to technical office via BIM model



Compound model, Rivka Oxman (2005)

Conclusions and future works

- BIM as a collaborative augmented reality environments;
- BIM in construction
- Compound model



Collaborative environment

Augmented-reality Google Goggles 'to replace phones'

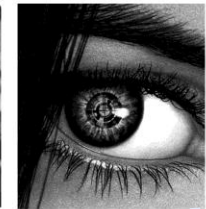
AN interactive pair of glasses could soon replace smartphones, Google announced yesterday.

The augmented-reality specs – con-

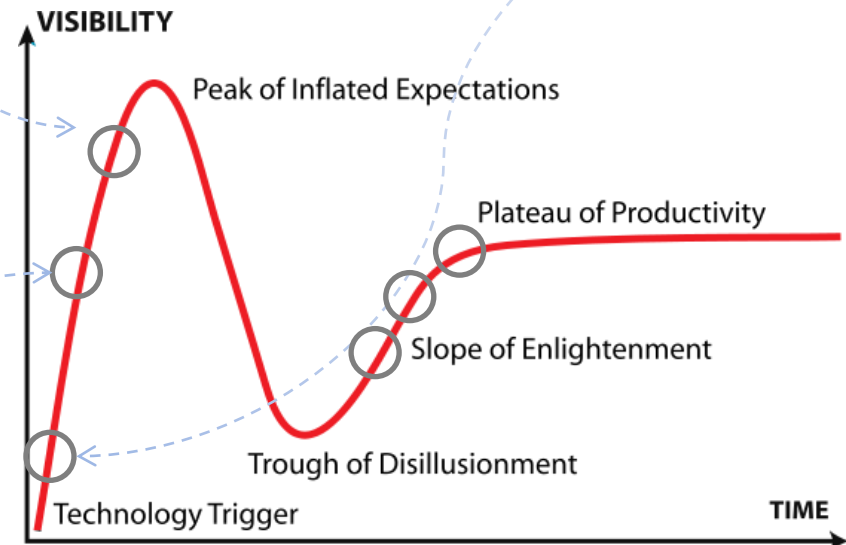
trolled by voice and even vision – will be able to make video calls, take pictures and give directions.

The technology, part of Project

Glass which has been dubbed Google Goggles after an existing app, will be tested by the public this summer and may be available by the end of the



April 4, 2012, Google Begins Testing Its Augmented-Reality Glasses



Technology Hype Cycle after Gartner

```
% cat < now.sh6 ; echo ---- ; now
#!/usr/bin/env sh6

: sh6 - " Force sh(1), csh(1), and other shells to exit w/ error! " <' ' ;;;

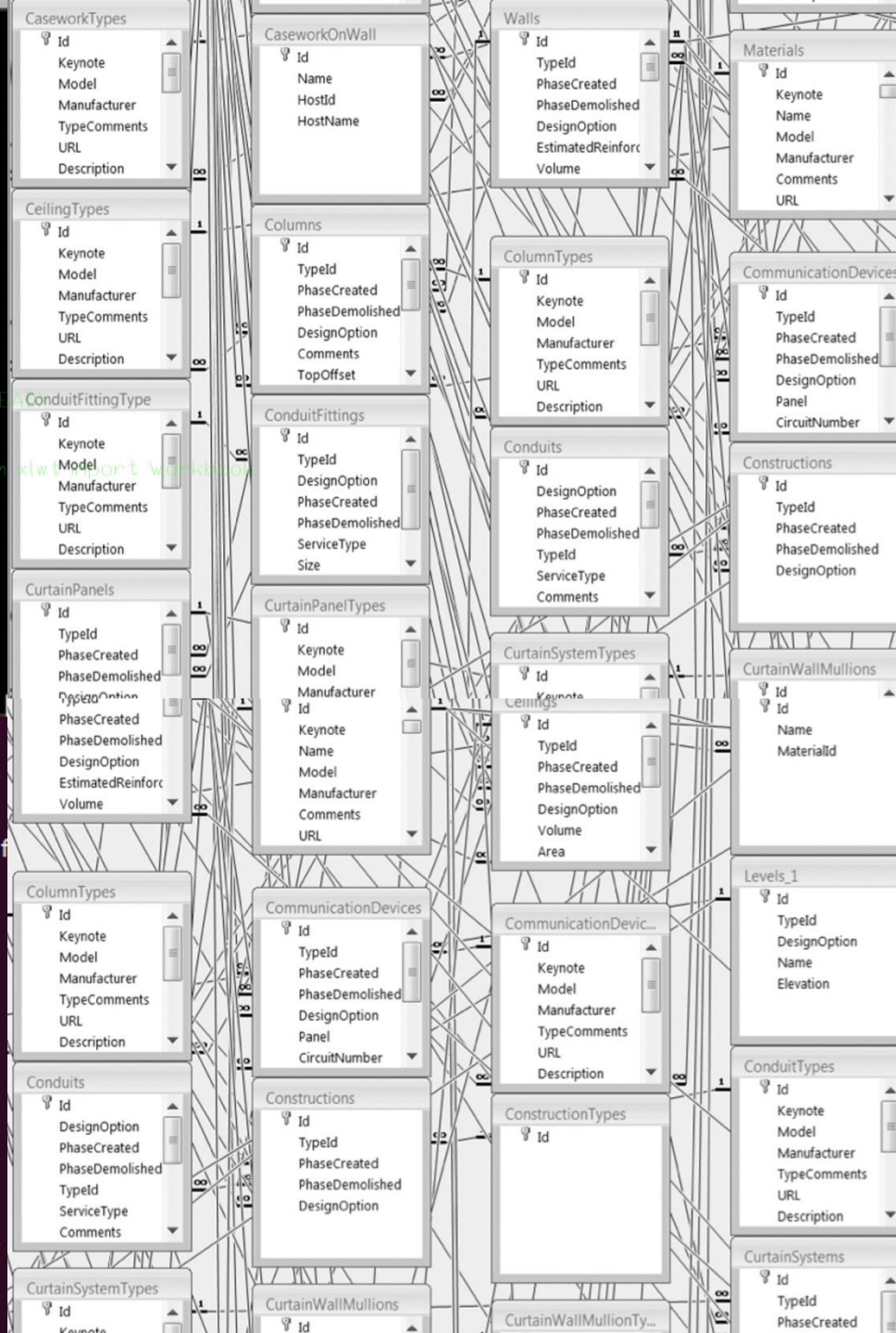
" @(#)$Id: 9f03f45f0545727a25ef7c07d6fb6d0a4361f625 $ "

" The author of this file, J.A. Neitzel <jan (at) v6shell (dot) org>, "
" hereby grants it to the public domain. "

from mmap import mmap,ACCESS_READ
from xlrd import open_workbook
print open_workbook('simple.xls')
with open('simple.xls','rb') as f:
    print open_workbook(
        file_contents=mmap(f.fileno(),0,access=ACCESS_READ)
    )
aString = open('simple.xls','rb').read()
print open_workbook(file_contents=aString)from xlrd import Workbook
data = [
    ['','2008','','2009'],
    ['','Jan','Feb','Jan','Feb'],
    ['Company X'],
    ['Division A'],
    ['100,200,300,400'],
    ['Division B'],
    ['100,99,98,50'],
    ['Company Y'],
    ['Division A'],
    ['100,100,100,100'],
    ['Division B']
]

: print the Python version number and exit (also --version)
arg : warning control; arg is action:message:category:module:lineno
also PYTHONWARNINGS=arg
: skip first line of source, allowing use of non-Unix forms of #!cmd
: warn about Python 3.x incompatibilities that 2to3 cannot trivially fix
le : program read from script file (all in enumerate(row):
: program read from stdin (default; interactive mode if a tty)
g ...: arguments passed to program in sys.argv[1:]

her environment variables:
THONSTARTUP: file executed on interactive startup (no default)
THONPATH : ':'-separated list of directories prefixed to the
default module search path. The result is sys.path.
THONHOME : alternate <prefix> directory (or <prefix>:<exec_prefix>).
The default module search path uses <prefix>/pythonX.X.
THONCASEOK : ignore case in 'import' statements (Windows).
THONIOENCODING: Encoding[:errors] used for stdin/stdout/stderr.
THONHASHSEED: if this variable is set to 'random', the effect is the same
as specifying the -R option: a random value is used to seed the hashes of
str, bytes and datetime objects. It can also be set to an integer
in the range [0,4294967295] to get hash values with a predictable seed.
```



References

- Kiviniemi, A., (2005) *Requirements Management Interface to Building Product Models*, Center For Integrated Facility Engineering, Stanford.
- Ciribini, A., (2013) *L'information modeling e il settore delle costruzioni IIM e BIM*, Maggioli, Segrate.
- Woodward, C. and Hakkarainen, M., (2011) *Mobile Mixed Reality System for Architectural and Construction Site Visualization. Augmented Reality - Some Emerging Application Areas*, InTechOpen 2012, Finland.
- Vanossi, A. et al, *Paths between real and virtual environments within a bim-based scheme*, in First uk academic conference on bim: conference proceedings, Newcastle Business School & School of Law Building, Northumbria, (2012).
- Eastman, C. et al., (2011) *BIM Handbook: a Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors*, 2nd edition, John Wiley & Sons Inc., New Jersey.
- Deutsh, R., (2011), *BIM and Integrated Design: Strategies for Architectural Practice*, 1st edition, John Wiley & Sons Inc., New Jersey.
- Hardin B., (2009) *BIM and Construction Management*, Wiley Publishing Inc., Canada.
- Nosyko AS, (1997) *dRofus Users' Guide*, Oslo
- Hjelseth E., (2010) *Overview of Concept for Model Checking* in Proceedings of the CIB – W78 2010: 27th International Conference, Cairo
- Oxman R. (2005), *Theory and design in the first digital age*, Faculty of Architecture and Town Planning Technion, Haifa 32000, Israel.
- Ahmad Rafi, M.E. and Mohd Fazidin, J., 2001. *Creating a City Administration System (CAS) using Virtual Reality in an Immersive Collaborative Environment (ICE)*, Architectural Information Management 19th eCAADe Conference Proceedings, Helsinki (Finland) 29-31 August 2001, pp. 449-453.
- Billinghurst, M. and Kato, H., 2002. *Collaborative Augmented Reality*. Communications of the ACM - How the virtual inspires the real. 45(7), pp. 64-70.
- Dunston, P.S. and Wang X., 2011. *An iterative methodology for mapping mixed reality technologies to AEC operations*, Journal of Information Technology in Construction (16), pp. 509-528.
- Milgram, P. and Kishino, F., 1994. *A taxonomy of mixed reality visual displays*. IEICE Transactions on Information Systems, Vol E77-D.
- Randell, C. and Muller, H.L., 2001. *Low-cost indoor positioning system*. Proceedings of UbiComp 2001: 3rd International Conference on Ubiquitous Computing, pp 42-48.
- The Associated General Constructors of America, 2005. *The Contractor's Guide to BIM - Edition 1*.
- Whyte, J., 2003a. *Industrial applications of virtual reality in Architecture and Construction*. Journal of Information Technology in Construction. 2(Special issue: Virtual Reality Technology in Architecture and Construction), pp 43-50.
- Whyte, J., 2003b. *Innovation and users: virtual reality in the construction sector*. Construction Management and Economics, September 2003(21), pp 565-572.
- Woodward, C., Lahti, J., Rönkkö, J., Honkamaa, P., Hakkarainen, M., Siltanen, S. and Hyvääkkä, J., 2007. *Case Digitalo - A range of virtual and augmented reality solutions in construction application*. Proceedings of 24th CIB W78 Conference, pp 529-540.
- Zauner J., Haller M., Brandl A., Hartmann W., 2003. *Authoring of a Mixed Reality Assembly Instructor for Hierarchical Structures*. The Second International Symposium on Mixed and Augmented Reality, ISMAR2003.