From BIM Requirements to Facility Management

BIM based scenario in a large-scale public building

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A. Tegon, CMB Carpi
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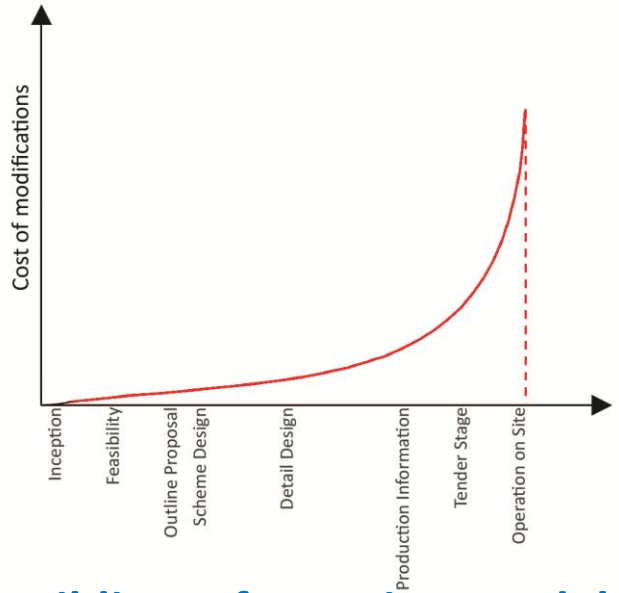
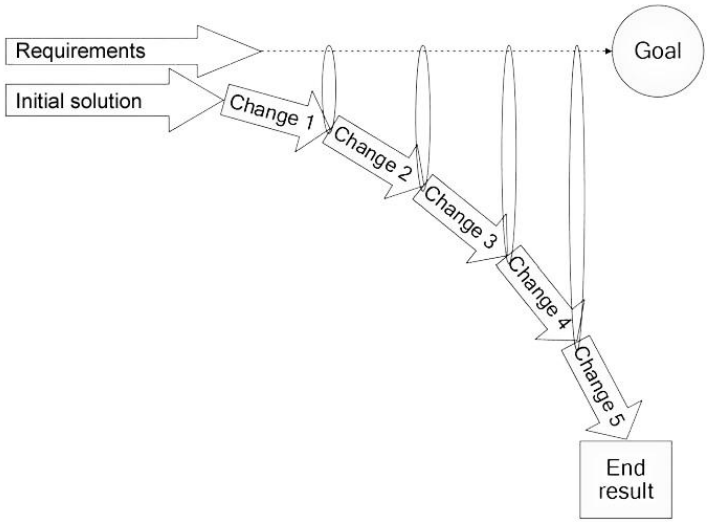


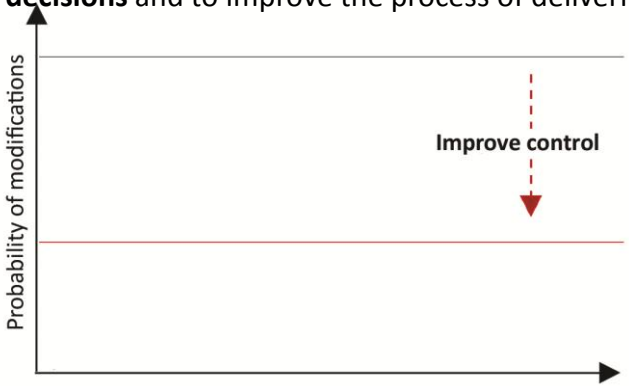
Cost of modification during construction phase



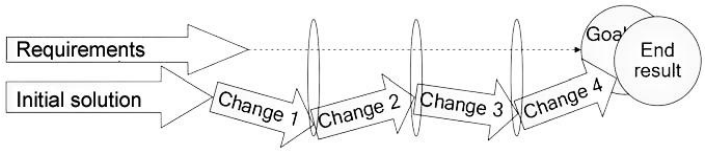
Shifting Away From The Goal

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)*



Benefit by improving control



Adjusting Design Solution

RIBA (2008) and author

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

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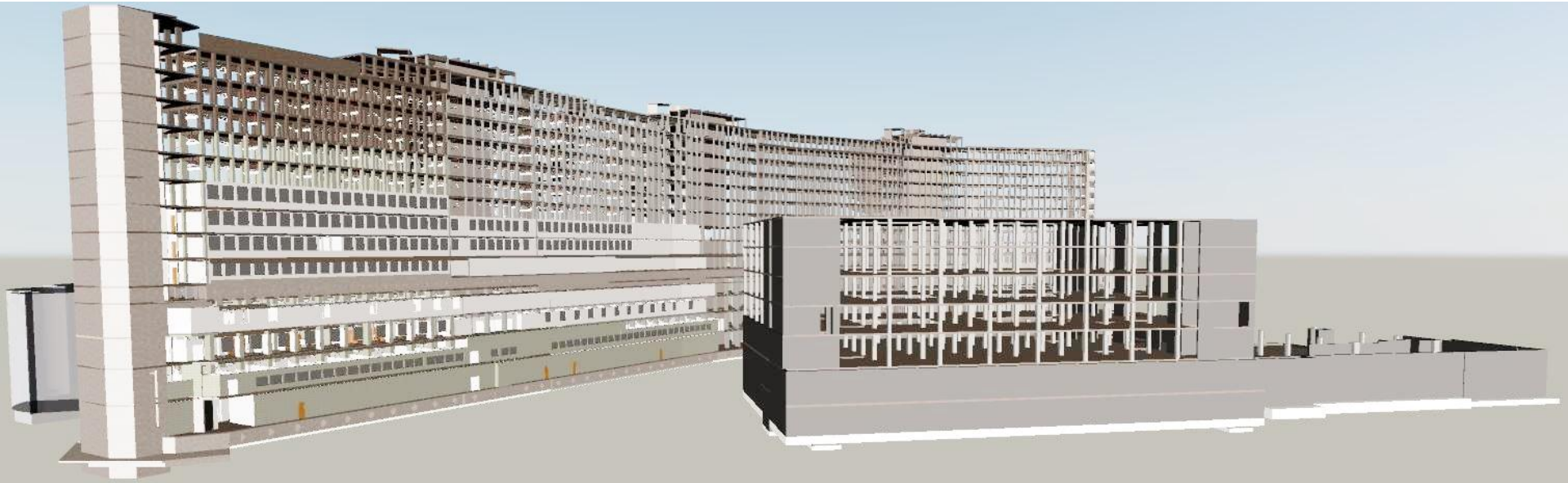
Bim Team:

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 il buildings (mainly hospitals). CMB s been active in construction since 08.

In recent years the CMB business s moved from simple construction ntracts, both public and private, to re complex forms of contracts, like P and Concession contract. Since 00, CMB has become more and more olved in the design, construction d facility management processes.

CMB's interest in the whole sup- chain of design, construction and cility management processes had ntinued to grow substantially and in 12 the management of the company cided to measure the impact of BIM starting a collaboration with the Uni- rsity of Brescia and some of the most portant software companies involved BIM.

During 2012 CMB developed a se- s of tests for field BIM and laser anning and developed parts of 3D odels based on projects managed in traditional way. At the end of 2012 MB decided to start its "*pilot*" project testing some of the main aspects of M implementation within the manage- nt of a hospital project: CMB BIM ot Project. CMB decided to start the ot project as a "*parallel activity*", and ntinued to use the traditional meth- s for the real management of the oject with the aim of trying to make mparisons between the traditional d BIM methods.

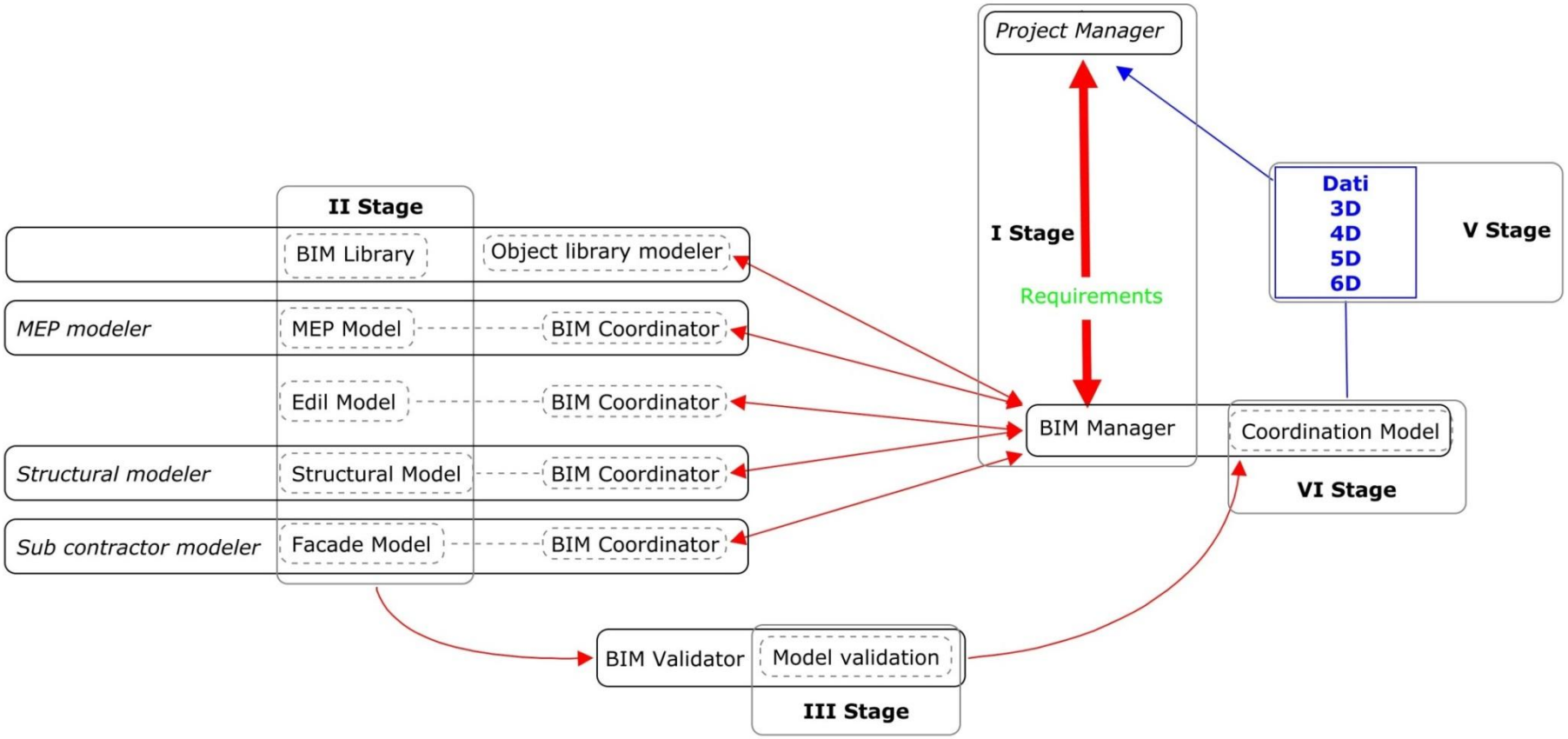
The CMB BIM Pilot Project is based a Hospital Refurbishment and Ex- tension Project: the San Gerardo Hos- pital in Monza, close to Milan.

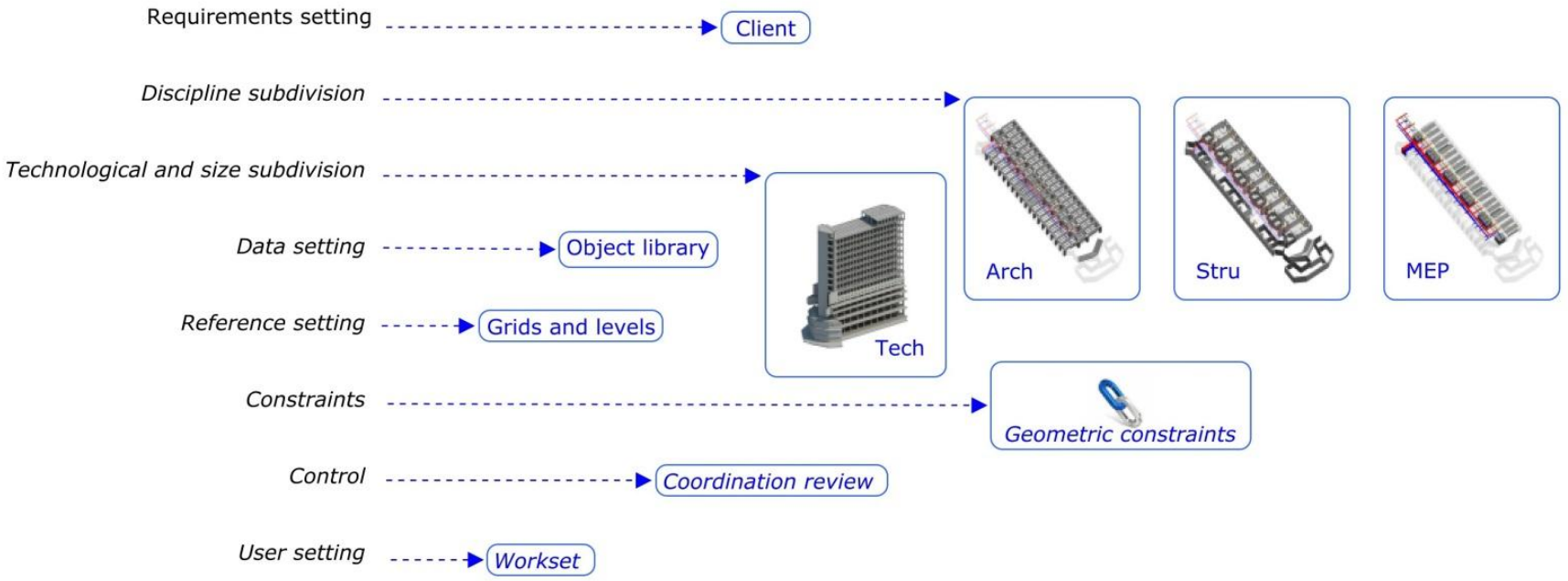
CMB BIM Pilot Project is almost at the end of its first phase (120 days) with a lot of interesting results coming from the tests developed. These results include the construction of the 3D model, quantity take off, coordination of designs, development of 2D deliverables and model checking.

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.

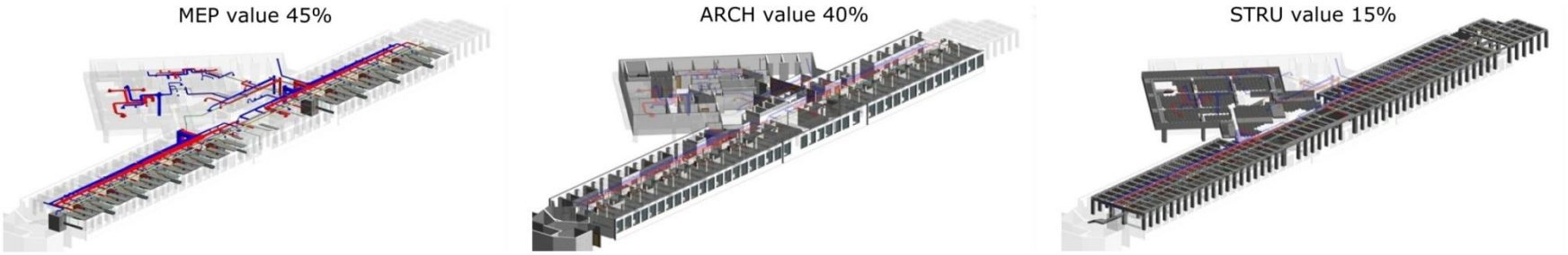
CMB is currently analyzing the results but the management of the company is already scheduling improvements to its processes and the

June 2013, Analysis of circulation for a wheelchair


Project Manager
I Stage
Requirements
Dati
3D
4D
5D
6D
V Stage
II Stage
BIM Library
Object library modeler
MEP modeler
MEP Model
BIM Coordinator
Edil Model
BIM Coordinator
Structural modeler
Structural Model
BIM Coordinator
Sub contractor modeler
Facade Model
BIM Coordinator
BIM Manager
Coordination Model
VI Stage
BIM Validator
Model validation
III Stage



BIM ***model setting***



BIM model divided by discipline and economic value

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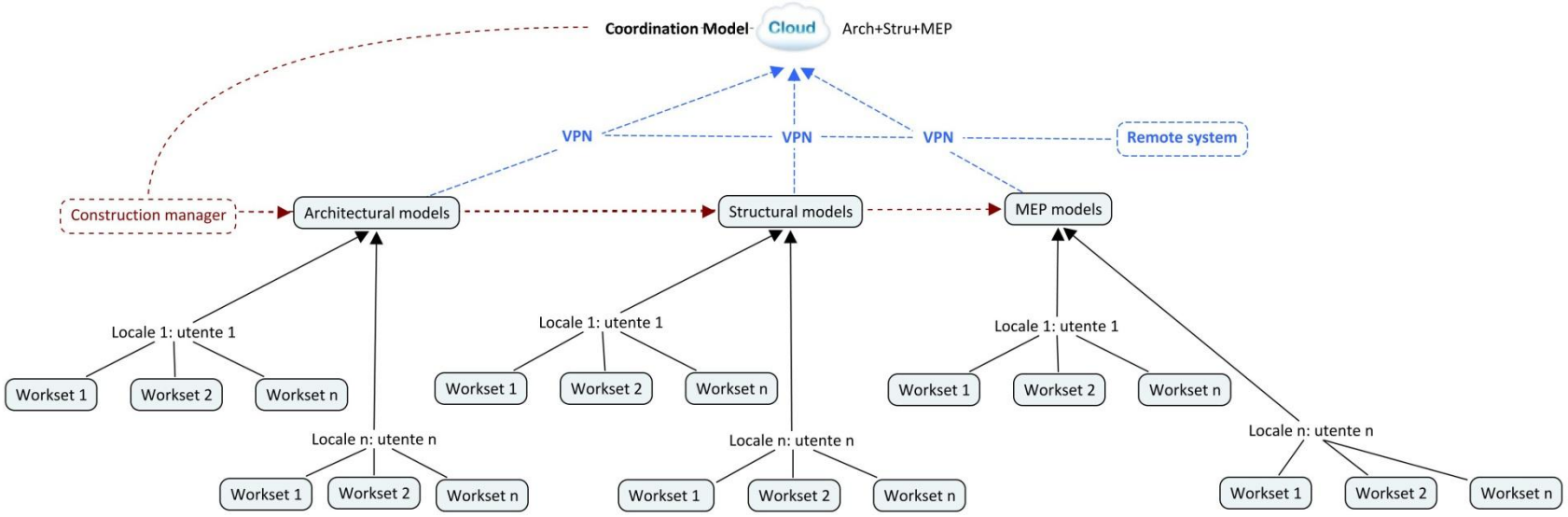
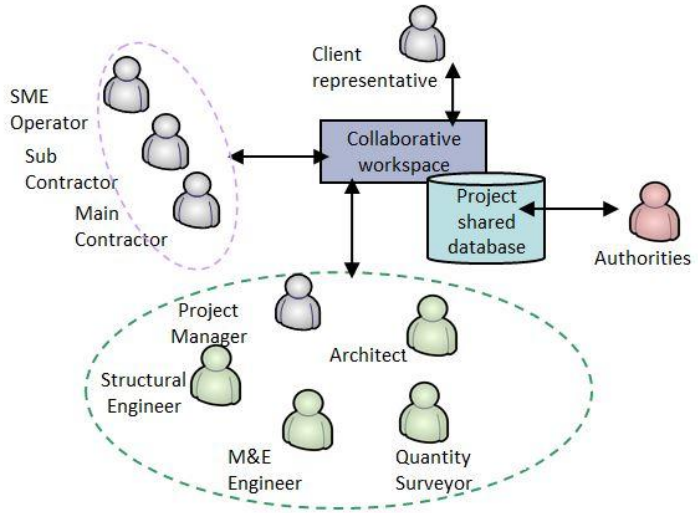
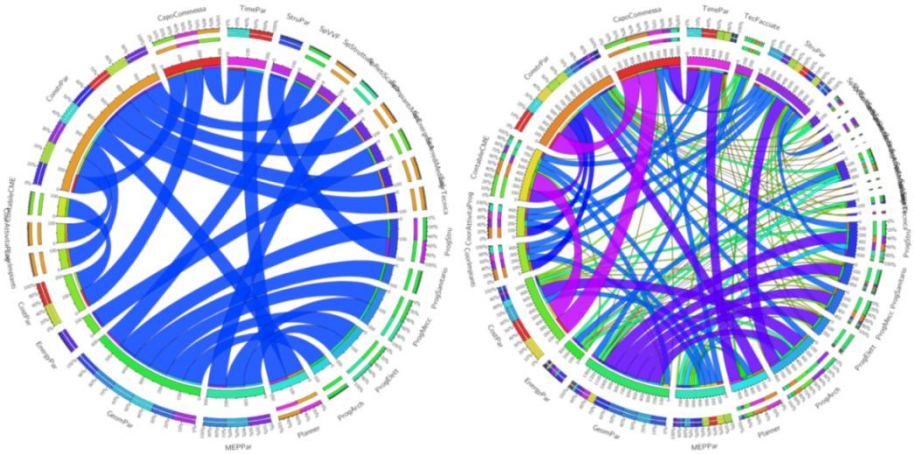




*Integrated **collaboration** workflow*

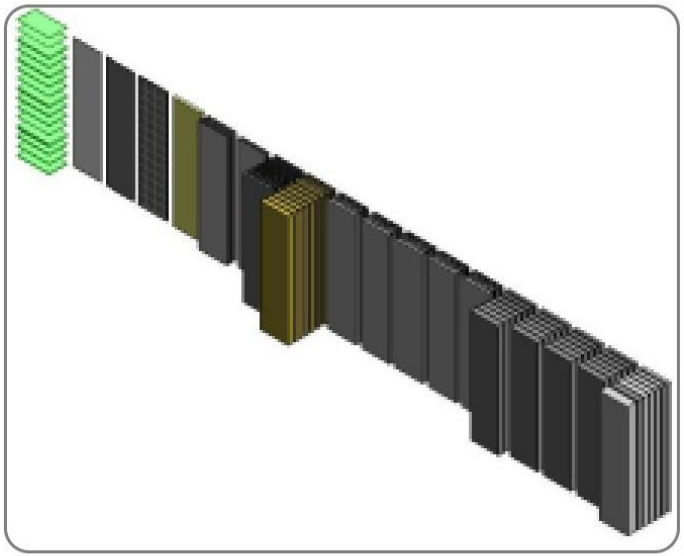


Comparison, relationship parameters /people, between traditional and BIM based process (Circos Table Viewer v0.63-9 © 2008-2013 Martin Krzywinski)

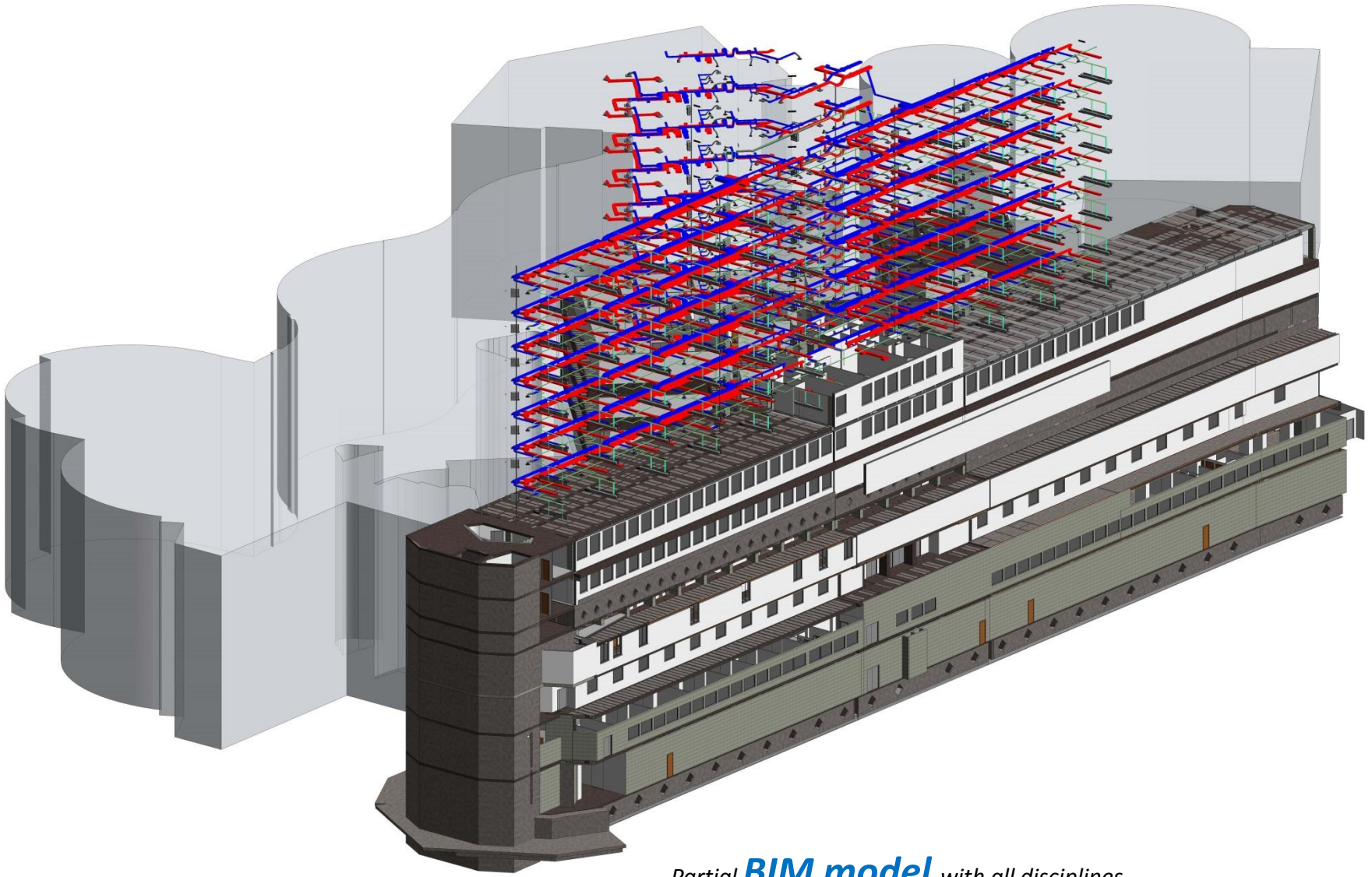
6D informations

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



6D customized objects ***BIM library***



Partial ***BIM model*** *with all disciplines*

Bim & Structure:

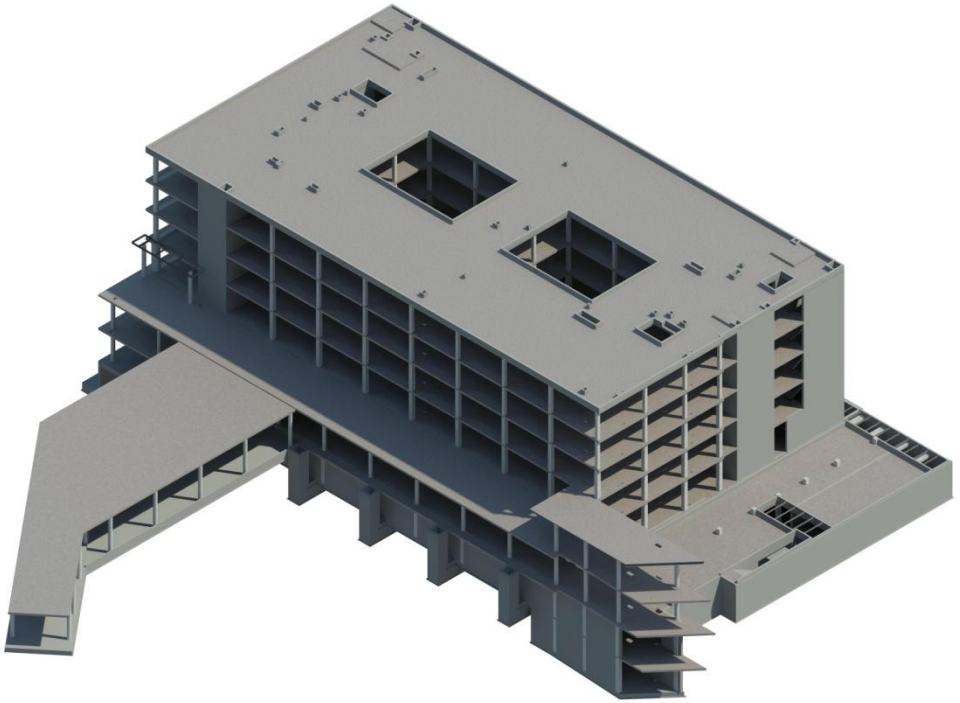
Buildings' frames are made of structures that suppo buildings.
Previously structures were not externally visible, but the are actually part of architectural elements that strong characterize the shape.

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

*Partial **BIM model** with all disciplines*

Bim & Structure:

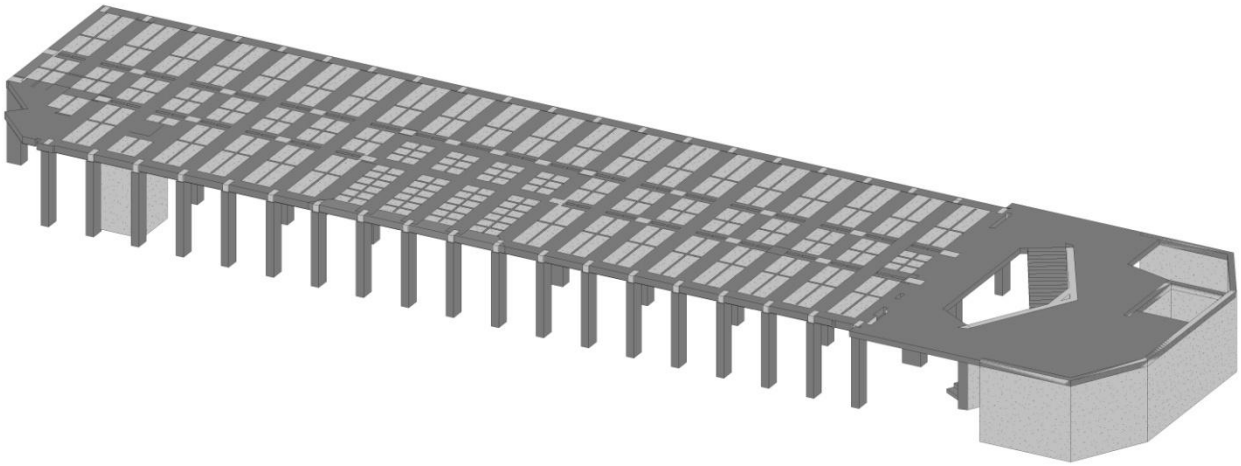
The definition of structural and mechanical properties of materials plays a decisive role in the field of structural design (ex.: the section of the structural elements directly dependent to the capacity of resistance). This conditions is true in the case of a reinforced concrete, but also in the case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



*Partial **BIM model** with all disciplines*

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.



*Partial **BIM model** with all disciplines*

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:

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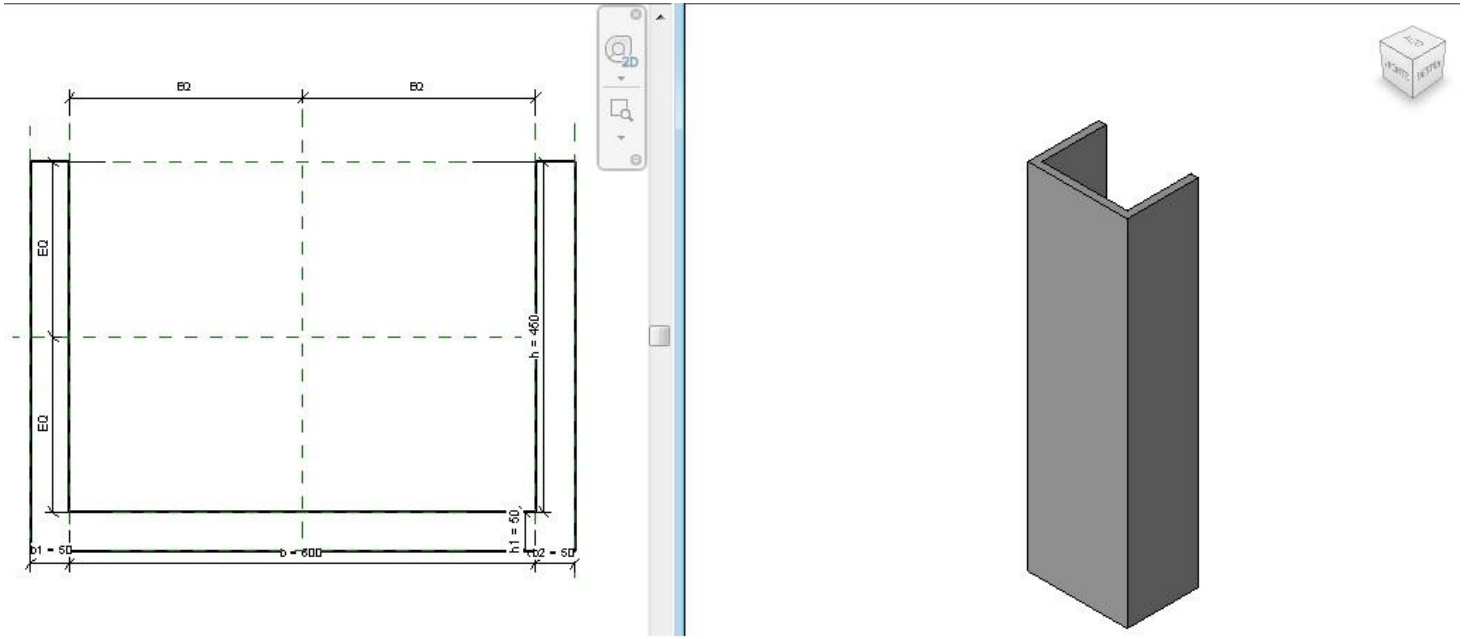
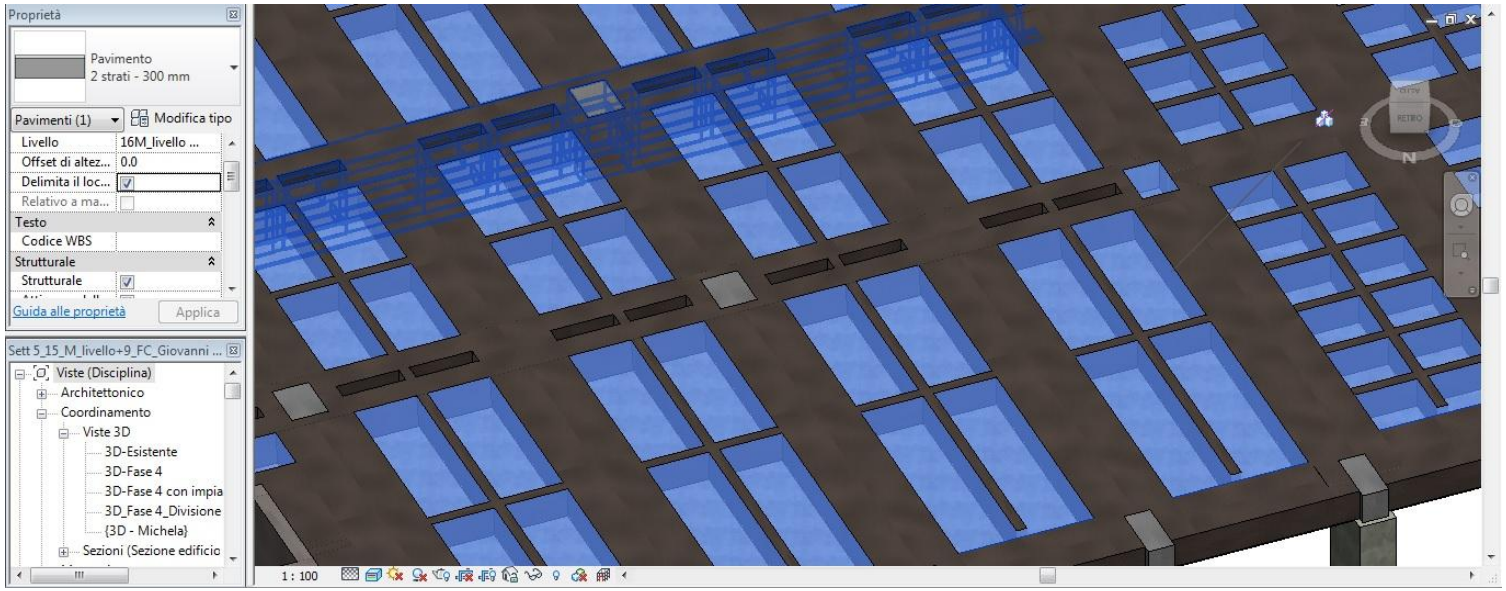


Partial ***BIM model*** *with all disciplines*

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.

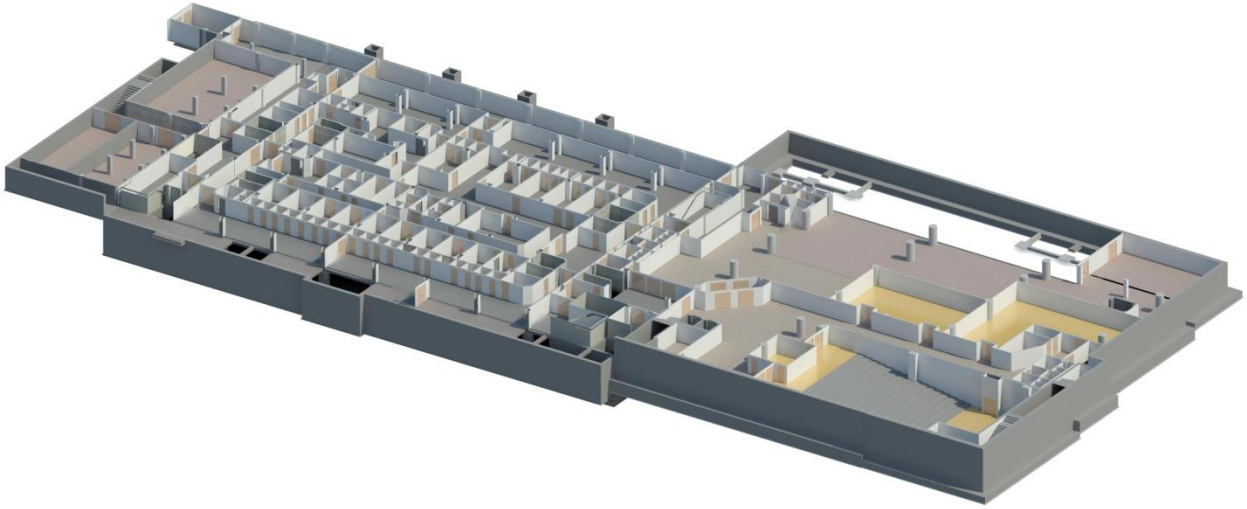


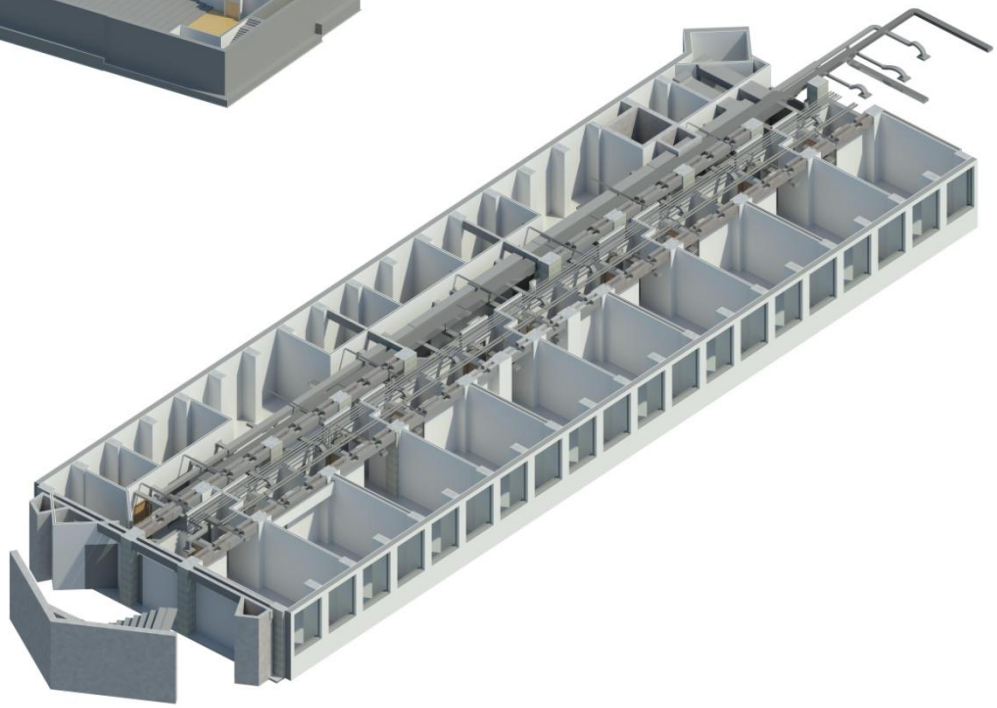
Partial ***BIM model*** *with all disciplines*

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*

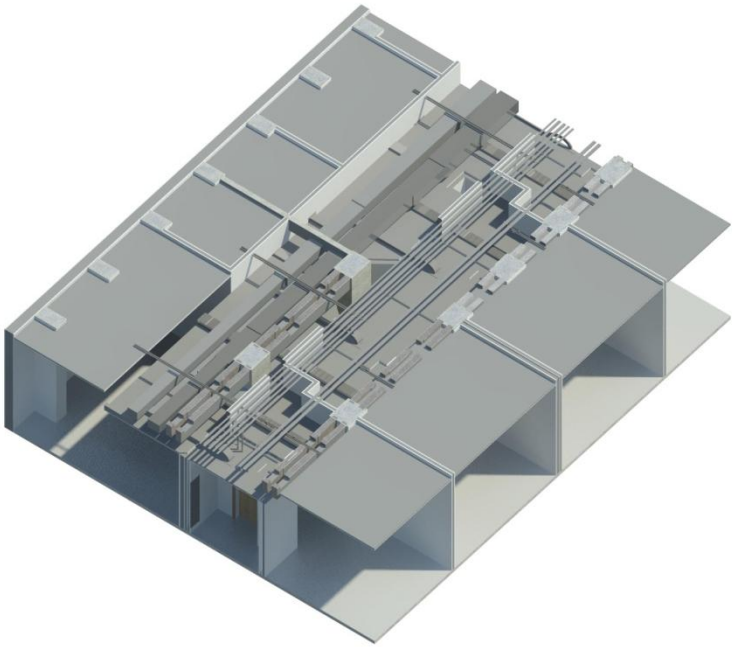




*Partial **BIM model** with all disciplines*

Criticality and Potential Development:

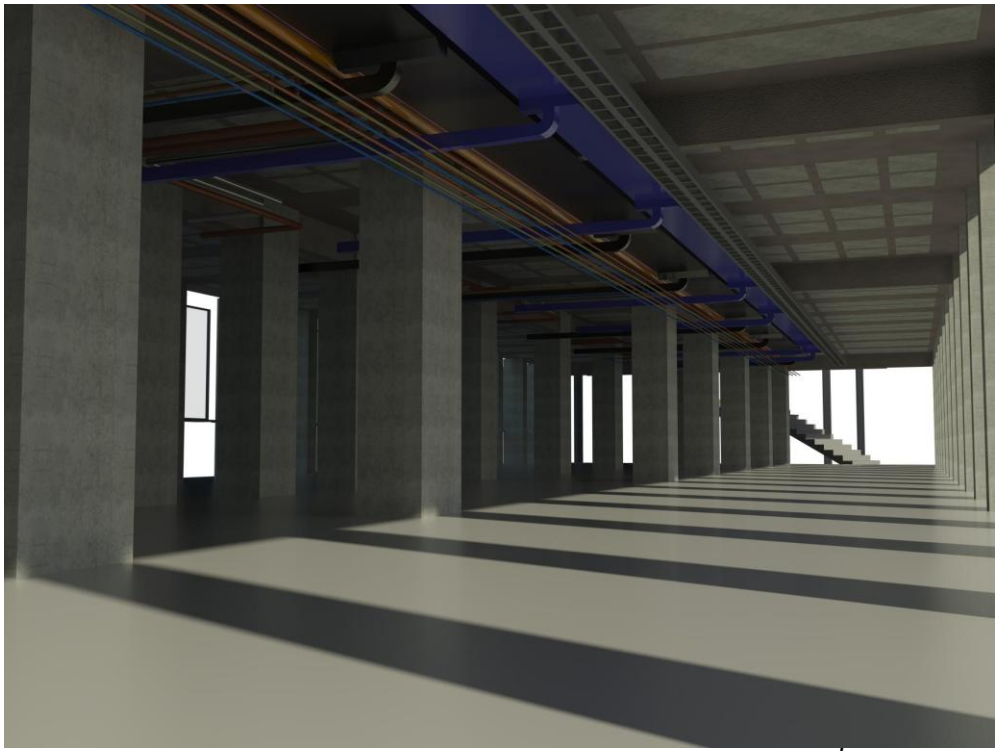
Finally, the Italian law requires the production of manual management of manufactured in which they must be described the way of action on non-structural but also must provide a "timetable" of the checks on the structural parts. This information can be incorporated into an intelligent BIM objects that 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.

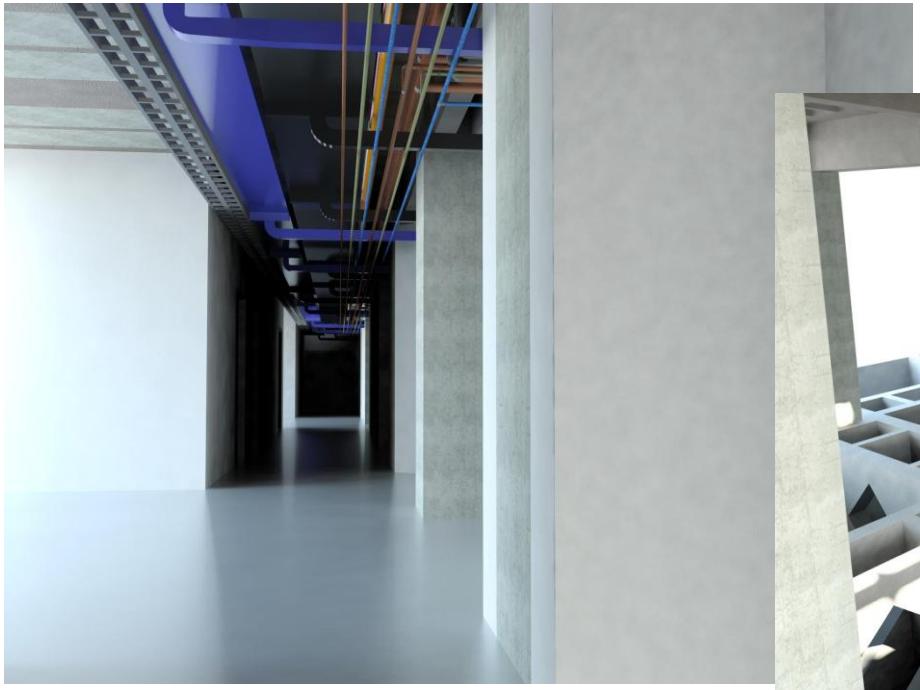


*Partial **BIM model** with all disciplines*

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.





Partial ***BIM model*** *with all disciplines*

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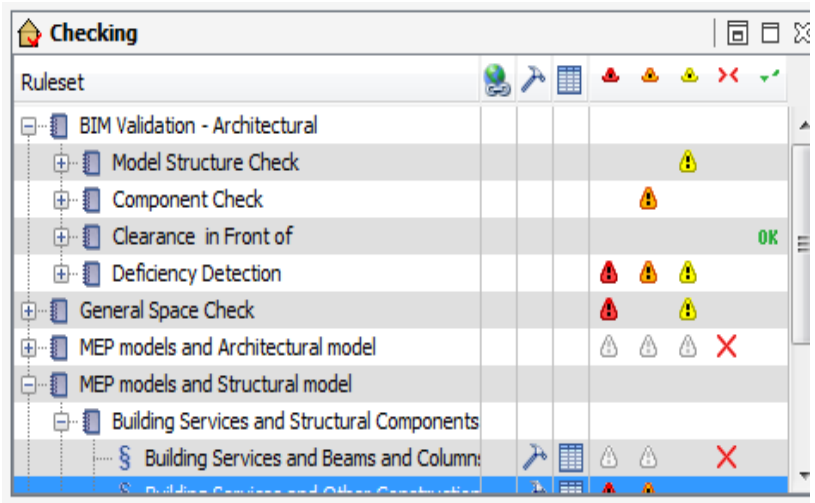
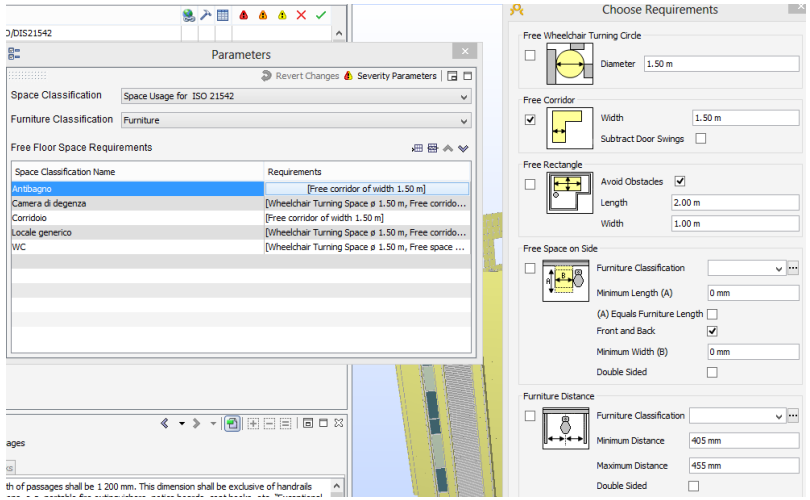
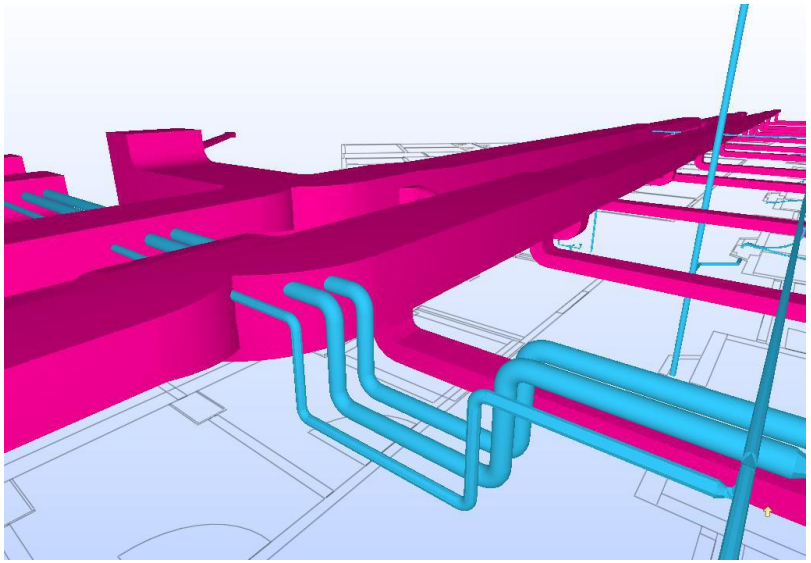




Solibri ***BIM validation***



Clash detection

Code checking

Model checking

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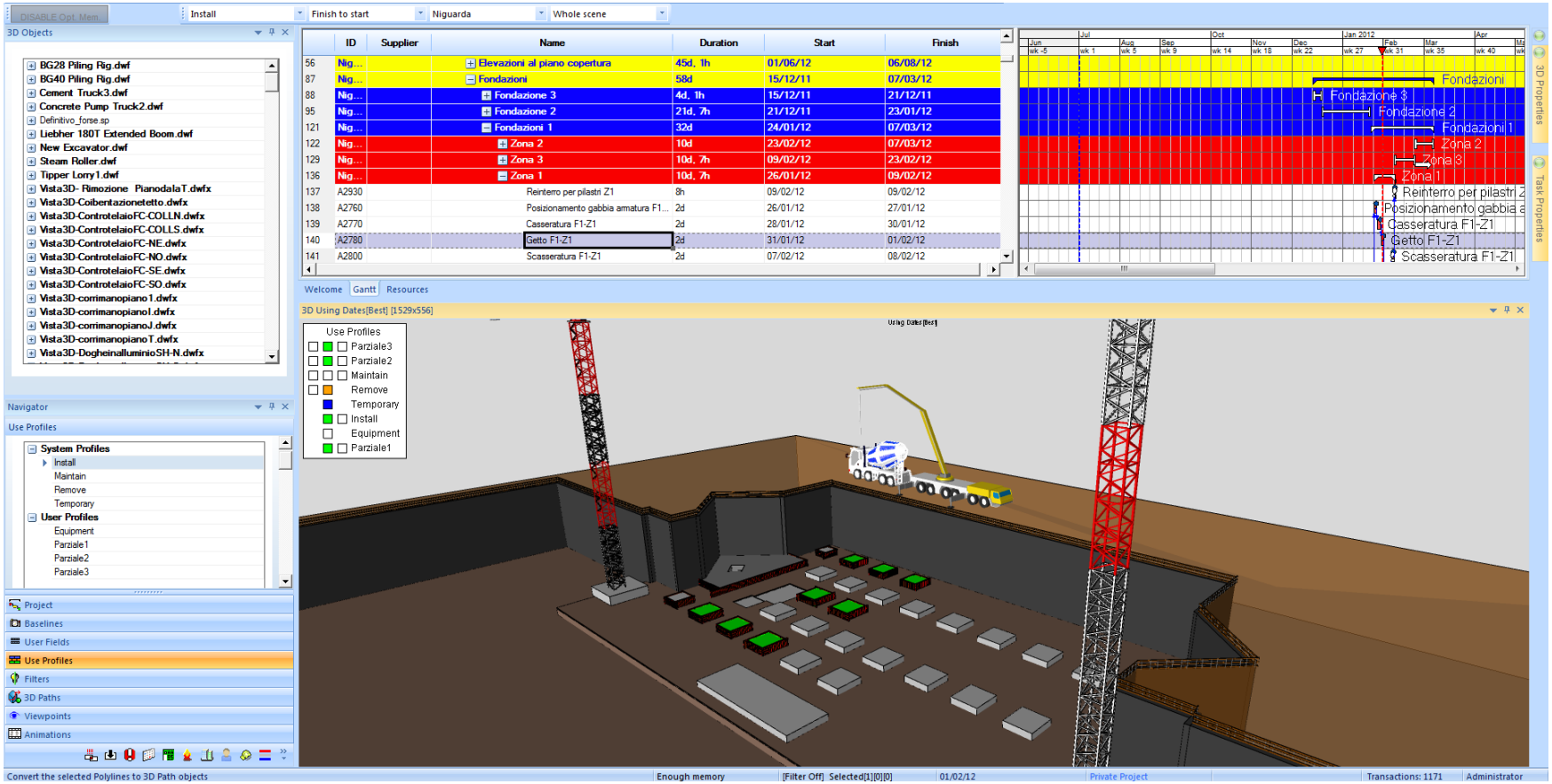

4D Synchro analysis

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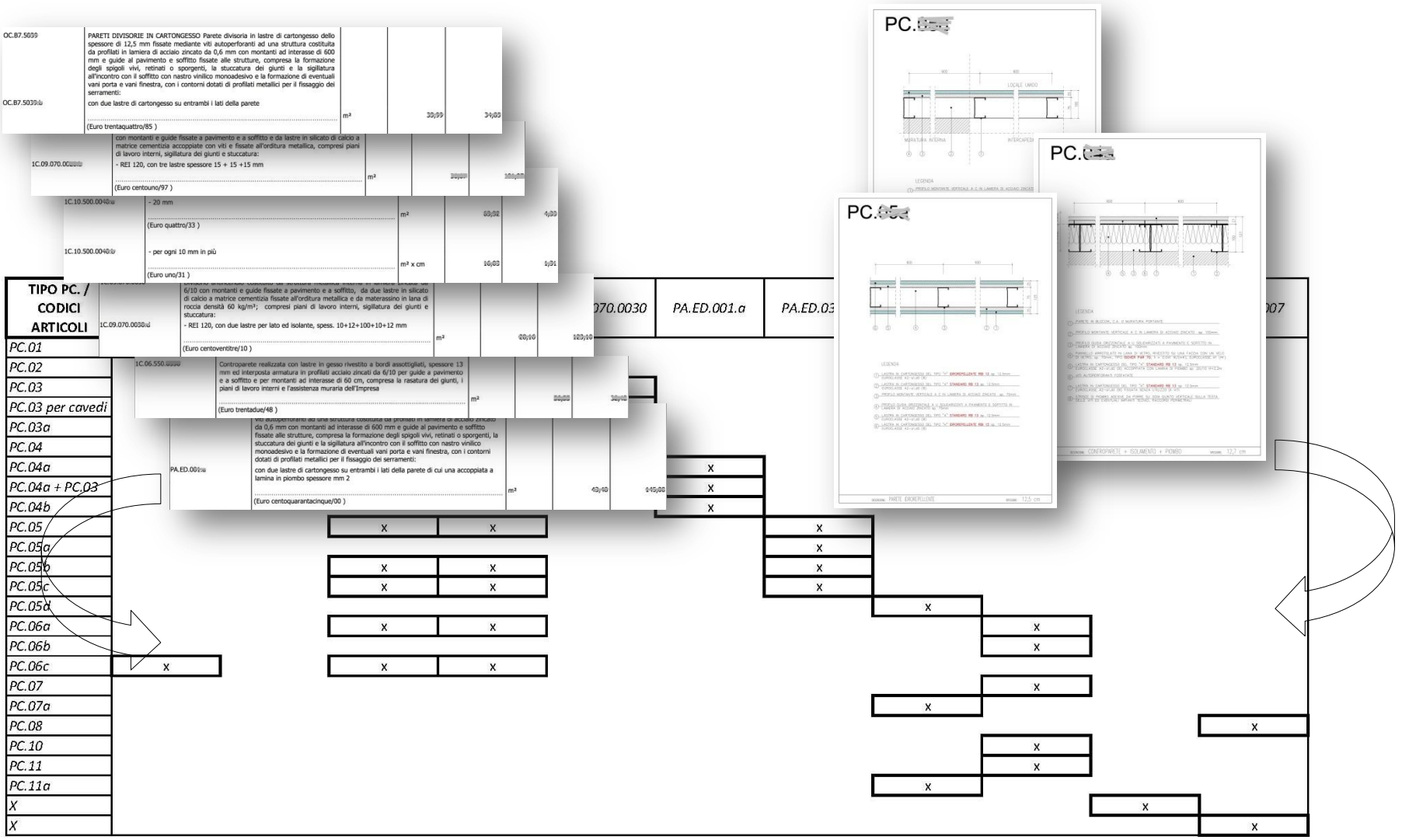
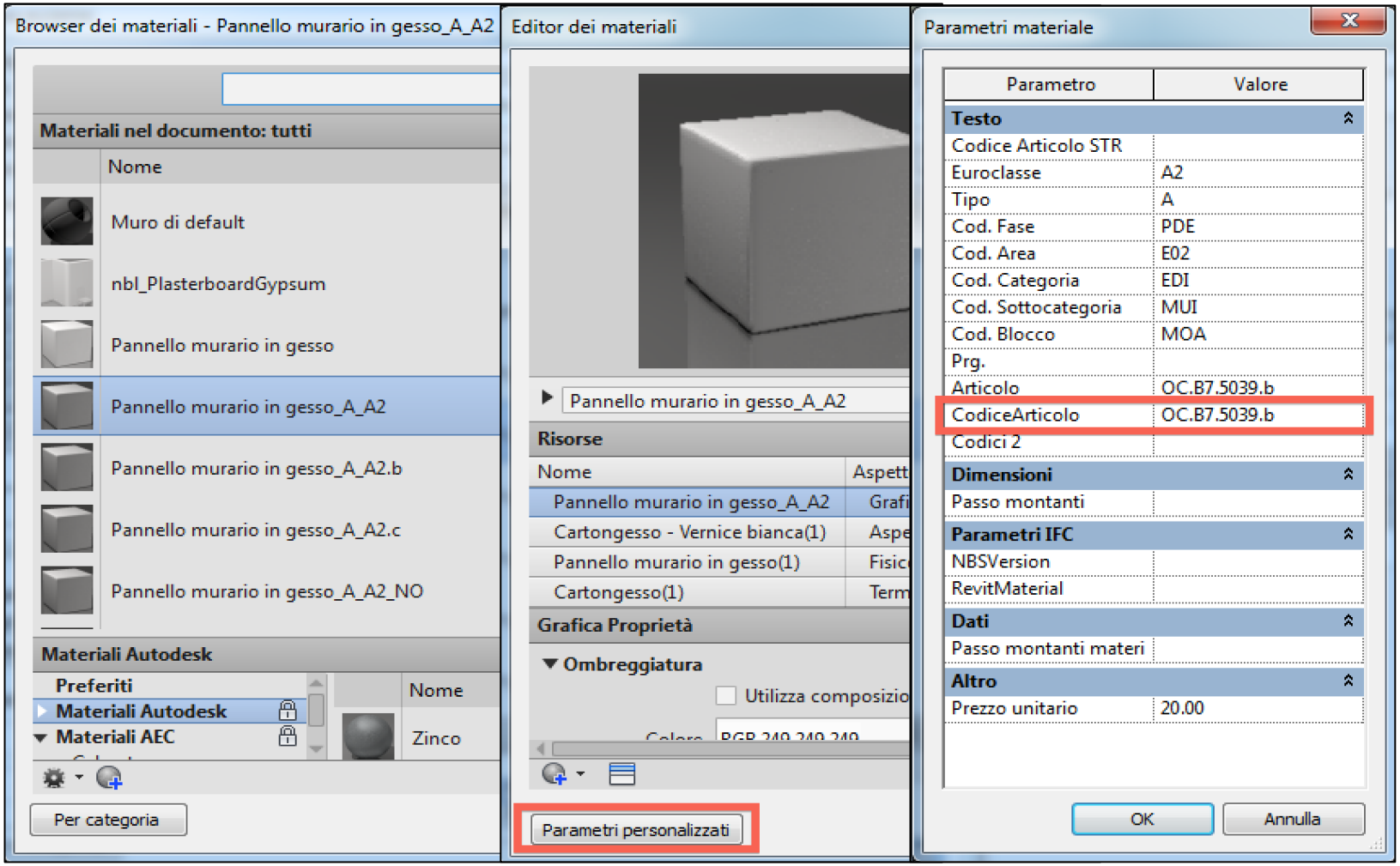
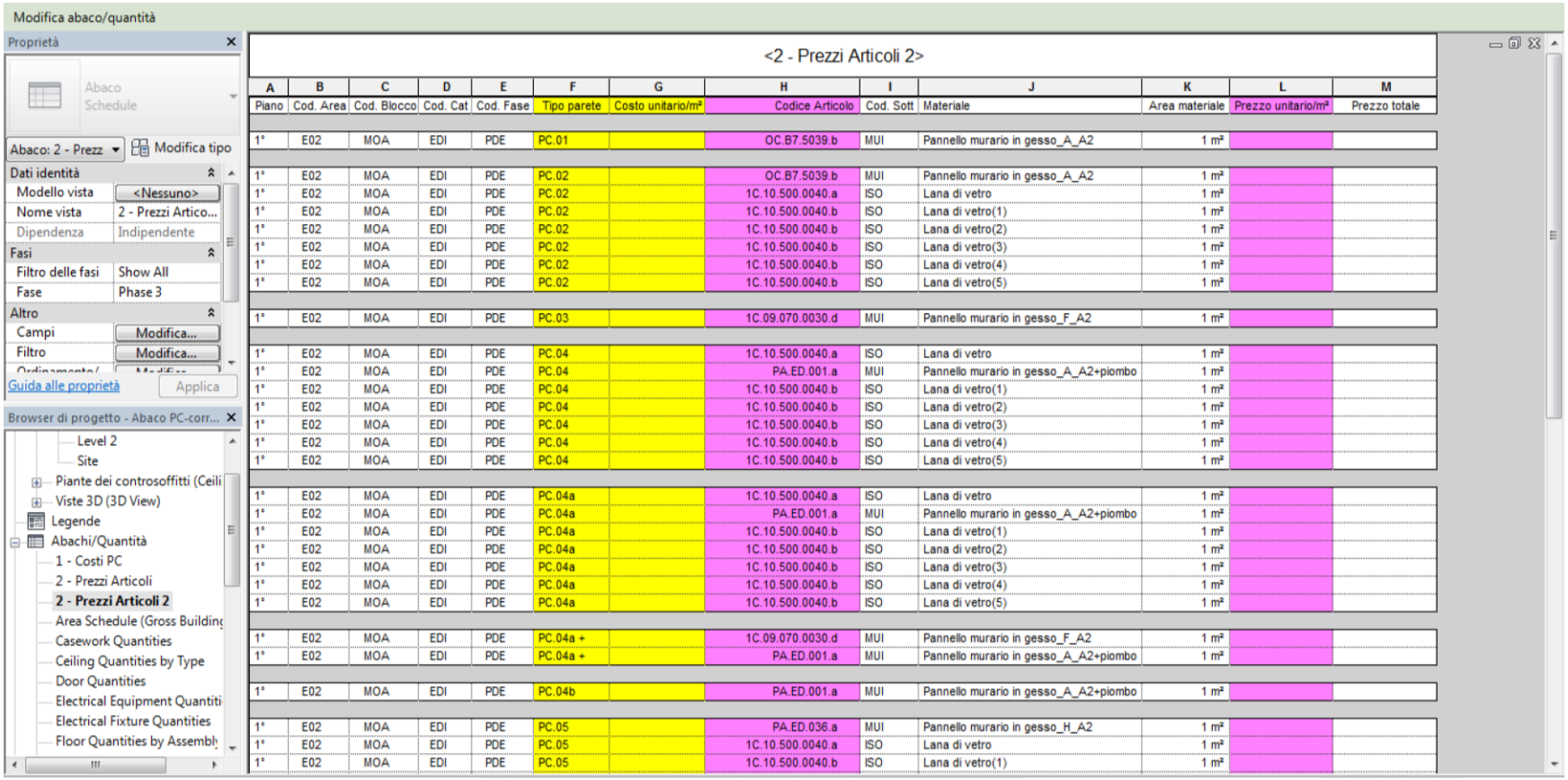


5D cost/gain's object identification matrix



5D matrix implementation in BIM objects through parameters

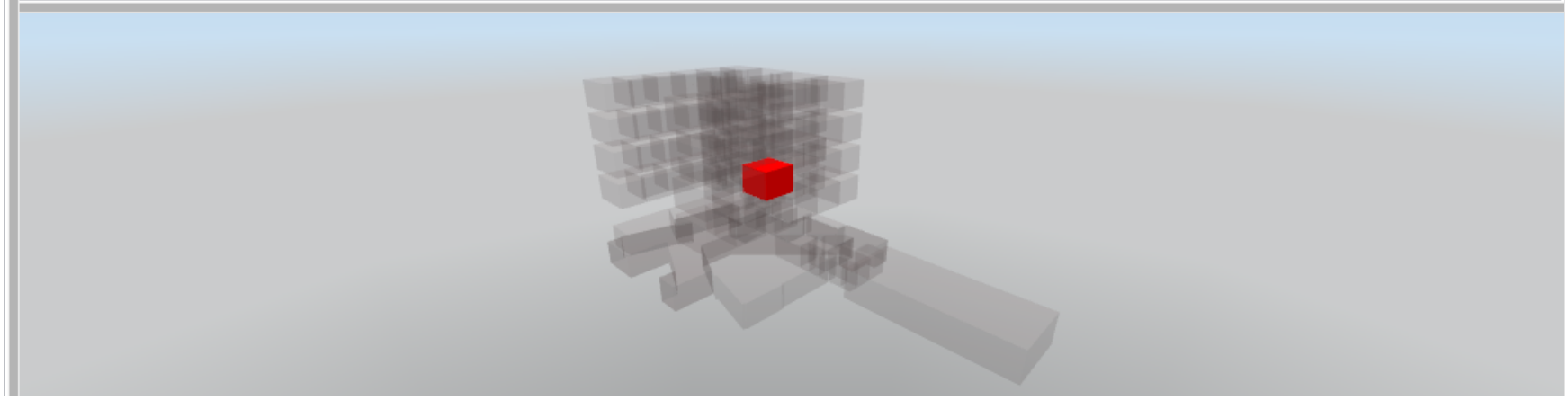


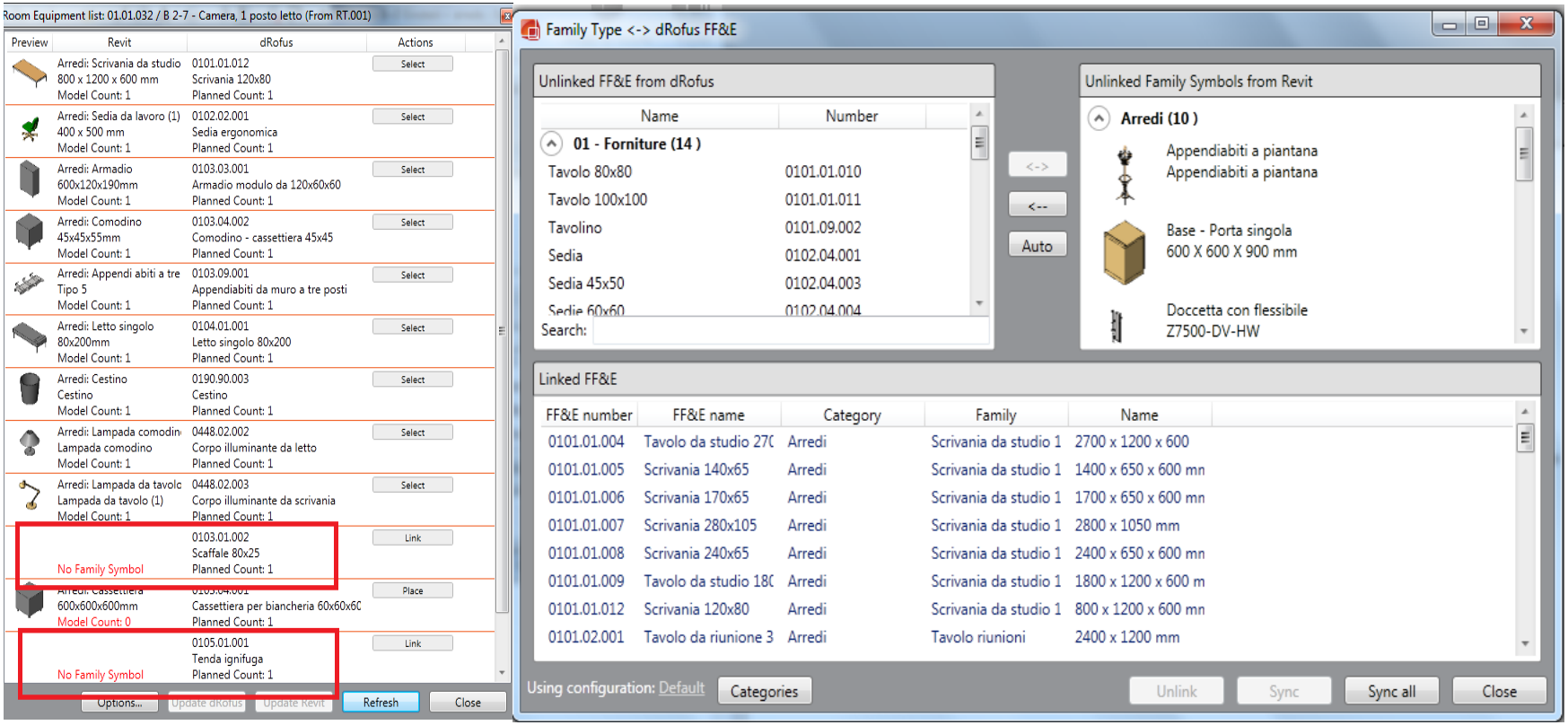
<2 - Prezzi Articoli 2>

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		

5D *gain/cost double analysis*

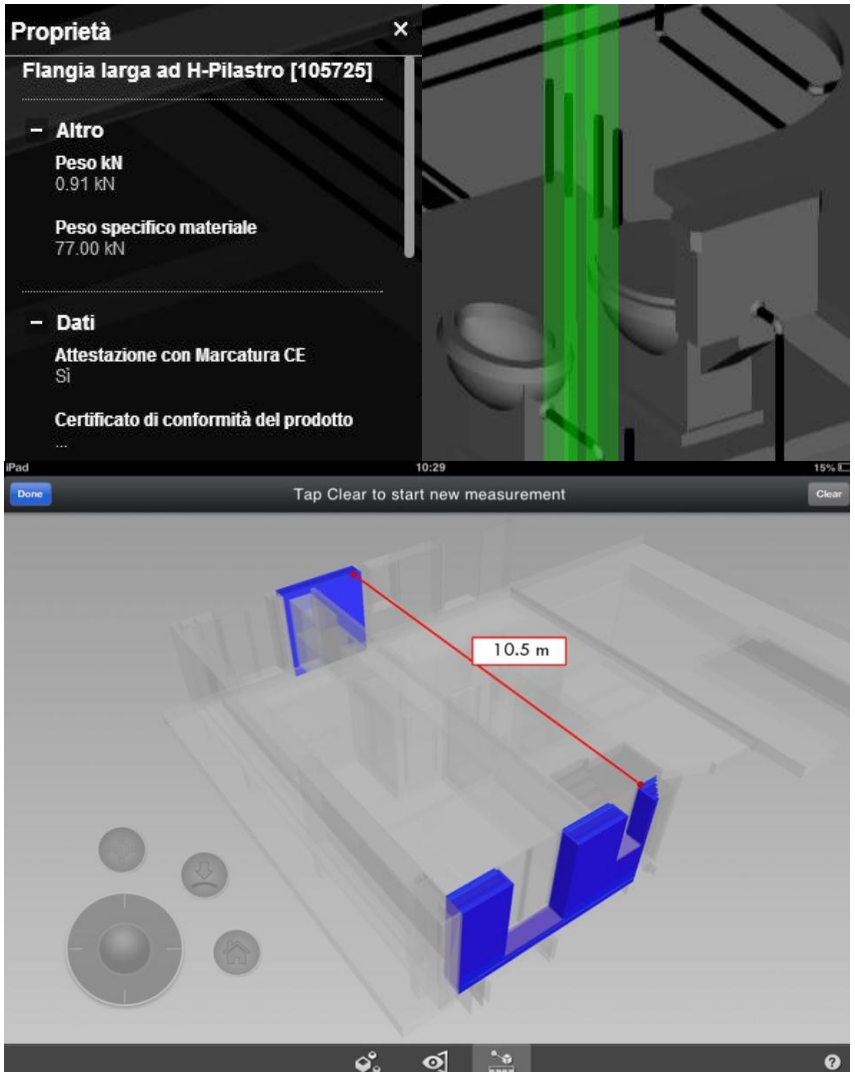
Room Function #:	Room Number:	Name:	Prog. ...	Design...	RDS status	Equipment status	Covering status
01.01.021	B 1-5	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
01.01.022	B 1-4	Camera, 1 posto letto	11.00	11.15	From RT.001	From RT.001	From RT.001
01.01.023	B 1-3	Camera, 1 posto 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



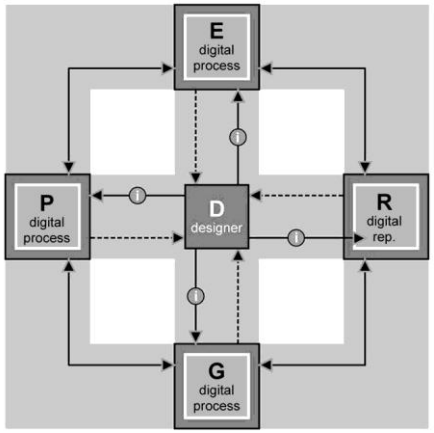


6D *dRofus objects's maintenance information linked to BIM model*

Lake Constance 5D-Conference 2013



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



Compound model, Rivka Oxman (2005)

Augmented-reality Google Goggles 'to replace phones'

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

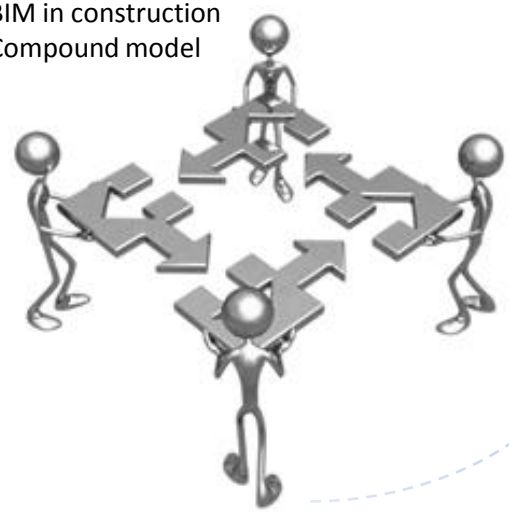
The augmented-reality specs – controlled by voice and even vision – will be able to make video calls, take pictures and give directions.

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

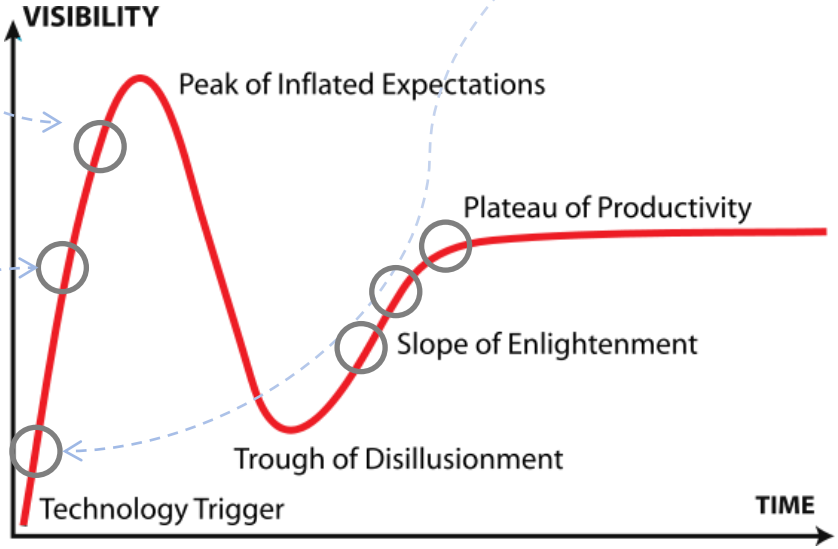
April 4, 2012, Google Begins Testing Its Augmented-Reality Glasses

Conclusions and future works

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



Collaborative environment



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.                               "
:
:
:
: "  Print the date and time in a nice ISO-like format.
:
: "  usage: now  "
:
:
: >>$0'' <''
killer $0 now

date '+%A, %Y-%m-%d, %T %Z'
----
Tuesday, 2012-01-10, 19:09:33 UTC
%
%
```

```
     : 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 f
le   : program read from script file
     : 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.
```

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