

Which drawing to deliver more information?

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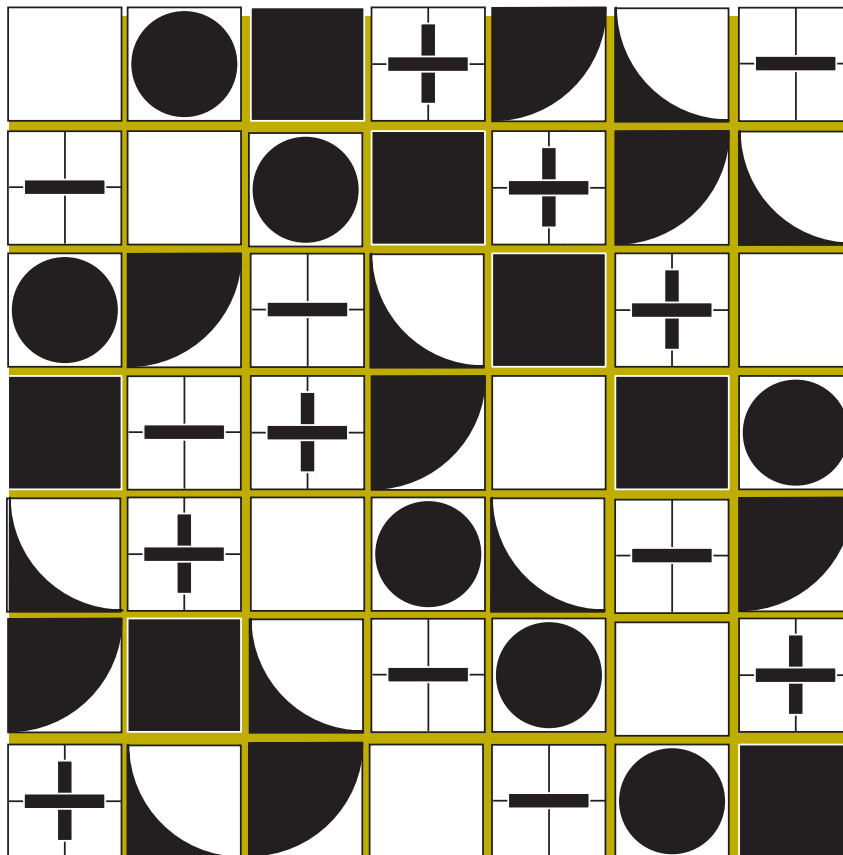
(Article begins on next page)

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Carmine Gambardella



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Less More Architecture Design Landscape
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Peer review Scholars has been invited to submit researches on theoretical and methodological aspects related to Architecture, Industrial Design and Landscape, and show real applications and experiences carried out on this themes. Based on blind peer review, abstracts has been accepted, conditionally accepted, or rejected. Authors of accepted and conditionally accepted papers has been invited to submit full papers. These has been again peer-reviewed and selected for the oral session and publication, or only for the publication in the conference proceedings.

Conference report 220 abstracts received from:

Algeria, Brazil, Bulgaria, China, Cuba, Denmark, Egypt, Estonia, France, Germany, Greece, Holland, India, Indonesia, Iran, Italy, Japan, Jordan, Kosovo, Malaysia, Malta, Mexico, Netherlands, New Zeland, Poland, Portugal, Puerto Rico, Russia, Saudi Arabia, Spain, Taiwan, Turkey, United Arab Emirates, United Kingdom, USA

More than 350 authors involved.

163 papers published.

Preface

Less, often leads us to reducing considerations and its linguistic application, generally, characterizes a condition of inferiority, decay or deprivation. If we make reference to the scope of our researchers, Architecture, Industrial Design, Landscape and to their deeper meanings, and if we use “less” before them we might involve a critic situation, or homologate a century.

An example is from the historical period we are living in, where Western economies are generically dealing with their budgets by cutting down on expenses rather than investing on their own heritage in order to create richness and workplaces.

On the contrary, our Researchers, Scholars, Businessmen and Civil Services Representatives want to use less to promote a shareable cultural reflection about the reduction of the waste of goods (raw materials, human resources, assets). That's why we are going to arrange the X International Forum “Le Vie dei Mercanti”. In this perspective Less does not mean less investments or cuts, but to identify a hierarchy of relevant sustainable investment funds based on the search for the know-how.

Less in Architecture, Less in Industrial Design, Less in Landscape subsumes more if we are able to supply regenerative models based on integrated system visions.

Consequently, More research in Architecture, More research in Industrial Design, More research in

Landscape if Local Human Resources are set up to create an efficient training education to be involved in the management, protection and regeneration of raw materials and human needs.

All along the past editions of the Forum I have drawn people's attention on our heritage as expression of "actual developing" (modernity).

Modernity, in fact, is an integrating part of history, an inexhaustible mine supplying raw materials to the Factory of Know-how which, as mentioned above, must get the same local physical geometric connotation as the generative humus about the production of fascinating items for Architecture, Industrial production, Landscape.

The projects our Faculty has dealt with, "Pompei Fabbrica della Conoscenza 0079/2013" or "l'Atlante del Cilento", witness as by sizing tangible and intangible heritage we can give rise to a productive factory aiming at art works and competitive Cultivated products and services.

So, scientific contributions aiming at collecting and spreading out the best practices and paradigmatic sustainable projects about system activities and elaborated in an assembly International dimension, are expected. Such contributions must be useful at enhancing an increasing Research process characterized by a constant learning and a great Know-how passion.

Carmine Gambardella

p. 0024 **ID 000**
Less/More Architecture Design Landscape
Carmine GAMBARDELLA

table of Contents _ Architecture

p. 0036 **ID 001**
Less or more.
Evolution of the concept of measurement and its precision.
Manuela PISCITELLI

p. 0046 **ID 003**
A "laboratory" open air in the urban landscape of Palermo.
Francesco DI PAOLA

p. 0053 **ID 004**
First results of an experimental campaign to study the influence
of cement/sand ratio on strength of cement mortar.
Luigi MOLLO

p. 0058 **ID 007**
More or Less.
Imprecise precision in "regulatory designs" by Galeazzo Alessi.
Paolo BELARDI

p. 0067 **ID 010**
The traditional house and rational architecture.
Flamur DOLI, Jetik DOLI

p. 0077 **ID 014**
Promotion of Cultural Heritage.
A case of a little village in Apennines.
Valentina CINIERI

p. 0086 **ID 015**
City and Architecture. Marginality and reappropriation.
The Case of Cavone in Naples.
Riccardo FLORIO

p. 0096 **ID 017**
Heritage architecture: a complex design with natural light.
Mounjia ABDEL TIF , Mejda BENCHAAABANE

p. 0102 **ID 020**
Simple tools for complex geometries.
Genesis and reconstruction of the Philips Pavilion.
Alberto SDEGNO

p. 0112 **ID 023**
Innovative technology and historic heritage: Italy's wealth.
Anna MANDIA

p. 0118 **ID 026**
Non invasive multi-technique analysis of historical
architecture for monitoring and conservation purposes.
Antonio SGAMELLOTTI, Costanza MILIANI,
Brunetto G. BRUNETTI

p. 0124 **ID 033**
Relationship between figurative codes and new
technologies in the 19th Century: knowledge of past
in order to design future strategies.
Laura FARRONI

- p. 0132 **ID 038**
The smart drawing for the knowledge.
The historic town of Ruvo di Puglia.
Cesare VERDOSCIA, Anna Christiana MAIORANO
- p. 0139 **ID 041**
On the connotation of the word “ksour”
in the Mediterranean.
Marinella ARENA
- p. 0147 **ID 042**
Jordan’s Umayyad Qasr: variation of invariant features.
Paola RAFFA
- p. 0157 **ID 043**
New technologies for the restoration of the modern
architecture: the case study of the Church of St. Mary
Immaculate of Longuelo.
Alessio CARDACI, Antonella VERSACI
- p. 0167 **ID 047**
The perfect proportion.
Eugenio MAGNANO DI SAN LIO
- p. 0173 **ID 051**
A forgotten architecture.
Alessandra MANIACI, Alessandra BRANCATELLI
- p. 0177 **ID 056**
Analysis of the masonry coursing pattern in the Casale
Castello: representation of the urban development.
Ingrid TITOMANLIO
- p. 0185 **ID 058**
EcoPerspectives Restoration.
Maria VITIELLO
- p. 0195 **ID 061**
From the complexity of architecture to the knowledge of the
construction of Siracusa.
Giacinto TAIBI, Rita VALENTI, Mariangela LIUZZO
- p. 0205 **ID 062**
A dynamic integral of software to support the ideational
thought.
Giacinto TAIBI, Massimo D’AIELLO, Giuseppa MANISCALCO
- p. 0213 **ID 063**
Energy consumption management
using CAFM application.
**Andrea ACQUAVIVA , Laura BLASO, Daniele DALMASSO
Matteo DEL GIUDICE, Giovanni Vincenzo FRACASTORO
Valerio R. M. LO VERSO, Enrico MACII, Anna OSELLO,
Edoardo PATTI, Anna PELLEGRINO, Paolo PIUMATTI**
- p. 0223 **ID 064**
Roshān vs. Jāli
Faredah Al-MURAHHEM, Vibhari JANI
- p. 0233 **ID 065**
Architecture, Ruins and the Landscape.
Anelinda DI MUZIO

- p. 0242 **ID 067**
 Geometric and constructive study of the
 Mediterranean Gothic Architecture with virtual models:
 Church of San Francisco in Morella.
Manuel CABEZA GONZÁLEZ, Alba SOLER ESTRELA
M^a Jesús MÁÑEZ PITARCH, Beatriz SÁEZ RIQUELME
José T. GARFELLA RUBIO, Ángel M. PITARCH ROIG
- p. 0251 **ID 070**
 The Theory of Linear Shadows and Chiaro-scuro.
Antonio MOLLICONE
- p. 0261 **ID 071**
 The ruled surfaces in stone architecture.
Federico FALLAVOLLITA, Marta SALVATORE
- p. 0270 **ID 075**
 Learning from historic wooden structures: sustainable
 performance since 18th Century in the Tropics.
Diana LUNA
- p. 0277 **ID 076**
 Huang Cheng Xiang Fu looking for development.
Fangli MA
- p. 0286 **ID 080**
 The ancient estate of Conca at the edge of the pontine marshes,
 between the views, surveys and historical maps.
Maria MARTONE
- p. 0295 **ID 083**
 Digital Representation of Archaeological Sites.
 Recent Excavation at Alba Fucens.
Leonardo PARIS, Daniela LIBERATORE, Wissam WAHBEH
- p. 0305 **ID 087**
 Generative architecture as a methodology of
 optimisation. Spanish examples.
Angélica FERNÁNDEZ, Zaira PEINADO
Luis AGUSTÍN
- p. 0315 **ID 089**
 More or Less... "Drawings" (as Heritage preservation).
Pedro António JANEIRO, Ivo COVANEIRO
- p. 0325 **ID 095**
 Utopias of the Radical movement as 'processes' for the analysis
 and design of public contemporary space.
Mónica VAL, Marina PUYUELO
- p. 0331 **ID 097**
 Architectural 3D modeling in historical buildings knowledge
 and restoration processes.
Mario CENTOFANTI, Stefano BRUSAPORCI
- p. 0341 **ID 098**
 Surveying simple technique.
Antonio ÁLVARO TORDESILLAS
- p. 0346 **ID 099**
 Retrofit of Casale Castello through the evaluation of the seismic
 safety of its masonry building types
Giuseppe FAELLA, Ingrid TITOMANLIO

- p. 0355 **ID 102**
Less energy, More quality. From Leipzig Charta to EPBD Recast.
Maria Teresa LUCARELLI, Antonella VIOLANO
- p. 0363 **ID 103**
From complexity of architecture to geometrical rule.
The case study of the dome of San Carlino alle
Quattro Fontane in Rome.
**Marco CANSIANI, Corrado FALCOLINI,
Giovanna SPADAFORA**
- p. 0373 **ID 105**
The interior as an exterior. Precedents for the addition of a new
hall in the old Gymnasium Neapolis, Crete.
Nikolaos SKOUTELIS
- p. 0379 **ID 109**
Palazzo de 'Mayo, multi-purpose and cultural center for the
town of Chieti.
Pasquale TUNZI
- p. 0385 **ID 111**
The system of forts of Rome.
Mariella LA MANTIA, Fabio LANFRANCHI
- p. 0395 **ID 112**
An integrated survey to digitally reconstruct the courtyard of
villa Rufolo in Ravello: from less to more.
**Barbara MESSINA, Pierpaolo D'AGOSTINO,
Maria Rosaria CUNDARI**
- p. 0405 **ID 113**
Water-ways from Naples to Miseno.
Maria Ines PASCARIELLO, Maria Rosaria TRINCONE
- p. 0412 **ID 114**
Study of efficiency for heritage documentation from image and
range-based information. Case study: San Martín Church,
Segovia.
**Juan José FERNÁNDEZ, Jesús SAN JOSÉ, José MARTINEZ
Luis Antonio GARCÍA, David MARCOS, Jorge GARCÍA**
- p. 0421 **ID 115**
Temporary architectures.
Daniela DE CRESCENZO
- p. 0430 **ID 118**
The energy-environmental behaviour of the pre-industrial basic
building: learning approach and applications.
Marina D'APRILE, Margaret BICCO
- p. 0440 **ID 119**
Measuring and Representing the city: past and present in
Giovanni Antonio Dosio's map of Rome (1561).
Antonella MARCIANO
- p. 0448 **ID 120**
To know so as to re-cognize and not forget.
Cristiana BEDONI
- p. 0457 **ID 121**
More complexity, less contradictions.
Concept Maps and Contemporaneity.
Maurizio UNALI

- p. 0465 **ID 124**
Tridimensional modeling as an opportunity to express projects never implemented: the case of Palladio.
Alessia MAIOLATESI
- p. 0472 **ID 125**
Cooperating in the holy land: The study of the ancient mortars of the old city of Akko (Israel).
Renzo RAVAGNAN, Paolo MARIANI, Manuela SGOBBI
Paolo BENSI
- p. 0483 **ID 126**
Vicinity of Carbonara in the land of Bari: stratigraphic tests and three-dimensional topology by scanning aimed at the recovery of a nineteenth-century building complex.
Claudia BISCEGLIA, Williams TROIANO, Michele FUNGHI
- p. 0494 **ID 127**
The "Fontana Rustica" in the gardens of the Quirinale. The three-dimensional laser scanning research for an overall framework non-invasive investigations.
Williams TROIANO
- p. 0503 **ID 129**
Less white, more white.
Giovanni Maria BAGORDO, Rocco VARIPAPA
- p. 0513 **ID 131**
The space "behind" geometry: didactics of projective geometry for architecture.
Andrea GIORDANO, Isabella FRISO, Cosimo MONTELEONE
Matteo BALLARIN
- p. 0523 **ID 132**
The importance of awareness in urban conservation and the role of children, Uskudar in Istanbul as a case study.
Hilay ATALAY, Yasemin TOSUN ANDIÇ
- p. 0531 **ID 134**
Harmony and Proportion in Traditional Oriental Houses. Where Less is More.
Mario KONG, Maria do Céu RODRIGUES,
Maria João PEREIRA NETO, Pedro JANUÁRIO
- p. 0536 **ID 137**
The role of drawing in regeneration of the paths of memory. The site of Caponapoli.
Teresa DELLA CORTE
- p. 0546 **ID 139**
XVI-XVIIth late gothic architecture in Busachi. Survey, three-dimensional modeling, diffusion on the web.
Paola CASU, Claudia PISU
- p. 0556 **ID 140**
The design of simplicity against the representation of artificiality or kósmos vs cháos.
Paolo GIORDANO
- p. 0570 **ID 147**
Less versus More: Ethics and Origins of Decoration in Architecture.
Alexandra AI QUINTAS

- p. 0576 **ID 148**
Only a huge stone-wall.
Michele Giovanni CAJA, Maria Pompeiana IAROSI
- p. 0586 **ID 149**
Forms and archetypes of the Nabataean façades at Petra.
Giuseppe MAZZACUVA
- p. 0597 **ID 151**
Anastylosis with Glass Fill.
Charles PHILLIPS, Tim MACFARLANE, John LEE
- p. 0607 **ID 158**
The visual description of the piedmont landscape in the historical iconography: from Theatrum Sabaudiae to landscape painters of eighteenth-nineteenth century.
Maria Paola MARABOTTO
- p. 0614 **ID 162**
Density changes in the redevelopment of the urban spaces.
Carlo Alessandro MANZO
- p. 0622 **ID 164**
In search of a strategy to bring back Iranian windmills to local life cycle.
Saeid GOLESTANI, Somayyeh SHARIFZADEH
- p. 0631 **ID 165**
Waste versus resource: updating a well-known practice.
Rossella FRANCHINO, Caterina FRETTOLOSO
Francesca MUZZILLO, Fosca TORTORELLI
- p. 0638 **ID 166**
Research, experimentation and social dimension of the residential building in Naples between the end of 19th century and the beginning of 20th.
Maria Rosaria DELL'AMICO
- p. 0650 **ID 168**
Less Architecture.
Francesco COSTANZO
- p. 0658 **ID 171**
The sad story of Carditello.
Riccardo SERRAGLIO
- p. 0666 **ID 180**
Recovery collective memory of places.
The Cirio industry in paestum (SA).
Mariarosaria VILLANI
- p. 0672 **ID 186**
Between memory and Mediterranean paradigms: drawing and graphical analysis of eighteenth-century villas in the territory of Bagheria (Palermo).
Gaetano GINEX
- p. 0681 **ID 187**
The contribution of the telematic university in the field of cultural heritage: the museum system between preservation and valorisation.
Tatiana KIROVA, Maria Cristina LAPENNA, Silvana ARICÓ

- p. 0690 **ID 191**
Which drawing to deliver more information?
Giuseppa NOVELLO, Massimiliano LO TURCO
- p. 0700 **ID 202**
Investigating on boundary.
Integration approach to architectural rapid characterization.
Alessandra AVELLA, Pasquale ARGENZIANO
- p. 0710 **ID 206**
Territorial seismic safety evaluation and appropriate survey:
liberty buildings in Naples.
Mariateresa GUADAGNUOLO, Adriana PAOLILLO
- p. 0719 **ID 207**
Cities in translation: the shapes of Earth.
Corrado DI DOMENICO
- p. 0729 **ID 208**
La Resurrezione of Pericle Fazzini in the Aula Paolo VI at the
Vatican. The restoration of contemporary art by sacred
multi-disciplinary dimensions.
**Carmine GAMBARDELLA, Saverio CARILLO, Danila JACAZZI,
Maria Carolina CAMPONE, Pasquale PETILLO,
Riccardo SERRAGLIO, Vincenzo SEPE,
Pasquale ARGENZIANO**
- p. 0759 **ID 211**
The Social Housing for a new ethic of architectural project.
Lorenzo CAPOBIANCO
- p. 0767 **ID 214**
Architecture and Urban Places.
Ottavia GAMBARDELLA
- p. 0773 **ID 215**
Complex of San Lorenzo ad Septimum.
Architectural contribution to sustain energy.
Efisio PITZALIS
- p. 0777 **ID 218**
Segezia.
Gianluca CIOFFI
- p. 0784 **ID 220**
The church in the theatre: the relation with the old age in the
architecture of Benevento in XVIII century.
Patrizia MOSCHESE

table of contents_ Design

- p. 0795 **ID 013**
Internationalization strategies followed by three mexican
pioneer companies, Grupo modelo, Grupo bimbo and Cemex.
José G. VARGAS-HERNÁNDEZ, Mohammad REZA NORUZI
- p. 0805 **ID 018**
The development of the printing division of the Korean
Government (1880-1910): Japan introduced modern printing
technology to Korea.
Hyun-Guk RYU

- p. 0815 **ID 024**
 An Equilibrium Towards LESS-MORE Problems?
 The Innovative Preservation of the Modern and
 Contemporary Cultural Heritage in Architectural Space.
Iwona SZMELTER
- p. 0824 **ID 052**
 The cities and the drawings. Street art projects as shared
 practices for the revitalization of urban areas.
Giovanni CAFFIO
- p. 0832 **ID 057**
 Urban prospection recovery of unused spaces for cultural uses
 and adaptation to existing urban strategies.
José Javier GALLARDO ORTEGA
- p. 0841 **ID 066**
 "Less is More".
 Eternal truth, eternal good and eternal beautiful.
Maria Grazia CIANCI
- p. 0851 **ID 069**
 Algorithmic Art-e- crafts.
 A Process Paradigm of Assembling 'Multiplicities'.
Evangelia PAVLEA
- p. 0861 **ID 073**
 Found objects and awareness in interior spaces.
Mergül SARAF
- p. 0869 **ID 116**
 A creative Lab of Design for outsiders
Marco BORRELLI
- p. 0876 **ID 138**
 Fashion Designers' Insight in the Global Crisis.
Karama THABET, Hazem ABDELFATTAH,
Alexandra CABRAL, M. A.
- p. 0885 **ID 144**
 Factors of industrial design through innovation.
Luis AGUSTIN HERNANDEZ, Laura ABAD TORIBIO
- p. 0893 **ID 170**
 OFFICIAMUSEUMED. The Mediterranean Museum System of
 Design and Applied Arts.
Claudio GAMBARDELLA, Jochen SIEGEMUND,
Ayse OZBIL TORUN
- p. 0906 **ID 177**
 Imagination applied to European norms in "humanized"
 hospitals. More research, less cost.
Anna MAROTTA
- p. 0915 **ID 178**
 "Life flourish again" for San Lazzaro Hospital in Turin.
 More sustainable colour, less stress.
Serena ABELLO, Chiara CANNVICCI, Marta BALZARRO

- p. 0924 **ID 181**
The use of Saudi National Identity in the development of originality and creativity among the students of the Fashion Design Department at Dar AL-HEKMA College to support the garment industry in the Kingdom of Saudi Arabia.
Hazem ABDELFATTAH, MS.DINA KATTAN, M. A.
- p. 0933 **ID 185**
Prototype design.
Rycycling, eco-compatibility and de-contextualization.
Antonino CALDERONE
- p. 0944 **ID 190**
Less versus More. Pondering Architecture and its Embodiment of Crisis.
Gerhard BRUYNS
- p. 0956 **ID 192**
Dualism and sensory awareness in architectural design.
Anna Marie FISKER, Mads Harder DANIELSEN
- p. 0966 **ID 197**
Urban Interaction Design an Other devices.
Alessandra CIRAFICI, Caterina Cristina FIORENTINO
- p. 0975 **ID 199**
From Sustainable Design to Empathic Design.
Ornella ZERLENGA
- p. 0985 **ID 209**
Color, Culture and Communication.
Laura CARLOMAGNO
- p. 0989 **ID 210**
[SMART]?: Sustainable Smart Innovation in Industrial Ceramics for Custom Multi-Product Design and Fabrication Strategies.
Stefano ANDREANI

table of contents_ Landscape

- p. 0999 **ID 002**
"Pluviogrammi" with high time resolution.
Maria Cristina MIGLIONICO, Giuseppe D'ANGELO
- p. 1009 **ID 005**
Amman's Land Typology: The Importance of Site Characteristics on the Delivery of Sustainable Buildings.
Sonia AL-NAJJAR, Wael AL-AZHARI
- p. 1024 **ID 006**
Minhocao Multiples Interpretations.
Eliana BARBOSA
- p. 1036 **ID 011**
Drawings for Engineering.
Laura INZERILLO
- p. 1046 **ID 019**
Environmental Planning: Case Study for Cocoa Coast Tourism Area – State of Bahia - Brazil.
Cristina Pereira de ARAUJO, Marco Aurélio GATTAMORTA Veridiana de Aguiar Coelho PINTO, Fernanda RHEIN, Elisangela Ronconi RODRIGUES, Sérgio Bernardes da SILVA

- p. 1054 **ID 021**
In the shape of a house.
Recycling the wastes of the city on the Neapolitan coast.
Fabrizia IPPOLITO
- p. 1061 **ID 022**
The documentation of cultural information used as vehicle for regional sustainable development. The case of olive culture.
Spyridoula ARATHYMOU
- p. 1067 **ID 028**
Testing Urban Landscapes.
Katrin KOOV
- p. 1075 **ID 029**
Technical and architectural integration of solar cooling system in a historical building.
Sergio SIBILIO, Efisio PIZALIS, Antonio ROSATO
Pasquale FALCONETTI
- p. 1082 **ID 031**
Archaeology and nature: hyblean cultural landscape and territorial regeneration.
Franca RESTUCCIA, Venera GRECO, Mariateresa GALIZIA
Cettina SANTAGATI
- p. 1092 **ID 032**
Industrial heritage, collective identity and eco-museums: the case-study of Floristella-Grottacalda mining site.
Antonella VERSACI, Alessio CARDACI
- p. 1102 **ID 034**
The tanneries di Barjols: a space built by reinventing.
Laura BLOTTO
- p. 1109 **ID 035**
The design of the urban centers of the Amalfi Coast.
Maria Archetta RUSSO
- p. 1119 **ID 046**
Cuma Archaeological Park: a communication strategies to improve public enjoyment.
Mara CAPONE
- p. 1129 **ID 048**
Road Infrastructures: methodological approach for the research of value added.
Michele CULATTI
- p. 1137 **ID 049**
Productive Landscape Design, a case study in southern part of Tehran.
Maryam SADEGHI, Zahra SADEGHI
- p. 1147 **ID 053**
Landscape of new energy.
Alessandra PAGLIANO
- p. 1154 **ID 055**
Camillo Sitte meets Robert Venturi at Berlin Südkreuz.
Jorg SIEWEKE

- p. 1158 **ID 060**
The design of sustainability in relation to innovative modernity and identity features of place.
Giacinto TAIBI, Rita VALENTI, Mariangela LIUZZO
- p. 1168 **ID 077**
Recognizing Cultural Heritage for Social Sustainability: A Spirit of Place Perspective.
Juliana FORERO, Liangping HONG
- p. 1178 **ID 078**
Teaching landscape architecture for the brain.
Miguel A. MEDINA
- p. 1190 **ID 081**
The landscape design between sustainability, heritage and new economies.
Maria Gabriella TROVATO
- p. 1200 **ID 082**
Drawings, signs and codes in landscape representation.
Stefano CHIARENZA
- p. 1210 **ID 090**
Open Spaces of Public Use.
Proposal of Methodology for their Classification.
Aylin PASCUAL, Jorge PEÑA
- p. 1220 **ID 092**
An example of integrated management of an heritage site: Bibracte – Mont Beuvray (Burgundy, France).
Vincent GUICHARD
- p. 1231 **ID 104**
Mythical landscapes: The Garden of the Villa “Ariadne” at Knossos.
Flavio ZANON
- p. 1238 **ID 106**
The city borders: new opportunities for the Mediterranean city.
Raffaella DE MARTINO, Luigi FOGLIA
- p. 1245 **ID 107**
Environmental Control of Toxicity of Urban Territories Using Biological Monitoring Methods.
Andrey VASILYEV, Leila KHAMIDULLOV, Liliana HYUKHTINA
- p. 1253 **ID 108**
Experience And Prospects of Environmental Planning of Towns of Russia Taking To Account Noise Factor.
Andrey VASILYEV, Vlada ZABOLOTSKIKH, Olga BYNINA, Julia TERESHCHENKO
- p. 1261 **ID 117**
A net of small museums for policies of planning, safeguard and government of Mediterranean archeological landscape.
Francesca FATTA , Domenico TOSTO, Andrea MANTI
- p. 1269 **ID 123**
Exploration of the open spaces in Varna as a component of the cultural landscape.
Todor BOULEV, Milena PETROVA

- p. 1276 **ID 130**
Jordanian villages and landscape: more sustainable planning, less physical and social degradation.
Ahmed ABU AL HAIJA , Franca GIANNINI
- p. 1288 **ID 135**
Cultural landscapes: materiality and spirituality in the mountains of Abruzzo.
Caterina PALESTINI
- p. 1295 **ID 141**
Overlays in Amalfi Coast: Less and More of the elements in the landscape.
Luigi CORNIELLO
- p. 1301 **ID 159**
A perspective from a contemporary point of view medieval.
Nadia FABRIS
- p. 1306 **ID 161**
Reflections on drawing the landscape.
Piero BARLOZZINI
- p. 1314 **ID 163**
Can large systems be resilient?
Inspiration from structural engineering.
Claudia CENNAMO, Bernardino CHIAIA
- p. 1324 **ID 167**
Chaotic development and urban morphology.
The sign of the architectural anarchy.
Gerardo Maria CENNAMO
- p. 1335 **ID 172**
The experience of the "Grands Sites de France".
Anne VOURC'H
- p. 1345 **ID 174**
On the soundscape of folk festivals as intangible cultural heritage.
Luigi MAFFEI, Maria DI GABRIELE, Saverio CARILLO
- p. 1352 **ID 175**
'Saving Istanbul's Ecosystem: TRANSMAR, Europe-Asia 50 km Floating Bypass Viaduct.
Ahmet VEFIK ALP
- p. 1357 **ID 194**
Recycling urban spaces. An alternative action research on sustainability and creativity in Irvy-Sur Seine.
Silvana SEGAPPELLI
- p. 1364 **ID 195**
From urban sprawl to eco-compact city: the urban renaissance.
Luigi MOLLO, Rosa AGLIATA
- p. 1372 **ID 196**
The case of an evangelical itinerary on Tiberias lake.
Cesare CUNDARI, Gian Carlo CUNDARI
- p. 1376 **ID 198**
Spectral analysis of wave characteristics on the back of submerged barriers in the Mediterranean.
Maria Cristina MIGLIONICO, Giuseppe D'ANGELO

- p. 1386 **ID 200**
Management models of sites of excellence in France for the rural landscape of the province of Caserta.
Alessandro CIAMBRONE
- p. 1396 **ID 201**
Knowledge and representation for landscape re-design: the area of Lago Piatto in Castel Volturno.
Nicola PISACANE
- p. 1404 **ID 203**
The process of the project by Marcello Piacentini object to the city: clarity and Expression for wise and balanced use of proportions.
Fabio CONVERTI
- p. 1413 **ID 204**
The Gisbusiness as a tool to manage change and innovation.
Gabriella ABATE
- p. 1421 **ID 205**
Cultural landscape and Culture of landscape.
Gaia GIORDANO
- p. 1428 **ID 213**
Speculations on the Future City.
Fatih RIFKI
- p. 1437 **ID 216**
"Carolino" Acqueduct landscape.
Gilda EMANUELE
- p. 1446 **ID 217**
Contribut of technological innovation to reinforce the multidimensional knowledge of environment and direct its development.
Lina ABATEGIOVANNI
- p. 1453 **ID 219**
LANDesign: from "Orto di San Lorenzo ad Septimum" to "Smart Garden".
Andrea BUONDONNO, Sabina MARTUSCIELLO, Maria Dolores MORELLI

Which drawing to deliver more information?

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Abstract

The paper explores the potential of methods and languages designed to facilitate the communication of appropriate information content for the different levels of detail required in the creation of an architectural design, levels with different purposes, but nevertheless co-ordinated.

Within this thesis, the many different facets of drawing and the language of graphics are confirmed as agents of intellectual mediation, as a support for expression and also as dynamic cultural and evolving factors. In order to reply to the new demands of performance, due to the increasing fragmentation of responsibility for design, some adjustments in the workflow are needed, essential to support renewed practices; in fact, supporting this dynamic, the representation seems to have recovered a role of increased visibility and importance, regaining an effective recognition through a reconfirmation that remarks the delicate function of communication, interpretation and criticism.

The added value of the BIM methodologies (Building Information Modeling), is not limited by the ability to handle graphical representations at different scales with a single 3D model, but it answers to some requests connected by the data complexity inherent with the design and construction, actively supporting the engineering process: this means to relate actors or the building process to each other in a new way, reforming the assets and the processing modes, requiring explicit coordination for activities and procedures.

At this regard, we analyze new operational workflow through a brief description of some designs carried out through the collaboration between DISEG (Department of Structural, Geotechnical and Building Engineering) and the Building Service of the Politecnico di Torino [1], speaking about drawings and representations.

Keywords: Building Information Modeling, database, drawing, representation

1. Foreword

It is always very hard speaking of architectural design ; on the other side, talking about some kind of work that may occur during the process that takes place between the moment of conception till its complete realization it could be paradoxically easier. Indeed, this statement is useful to limit the area of interest of the following arguments, having the contribution that is declared in the title: being able to identify some critical aspects of the working-out processes, focusing the attention on those methodologies that are best suited to manage the complexity information of the design representation. [2]

The theme is not certainly new, but the purpose is to update some mentioned thoughts with the comments suggested by the latest operating procedures, in order to present some experiences conducted directly on the field. We are inspired by the intention “to exert ourselves”, in order to critically analyze and to abstract some principles of methodological value; this seems to be still the task of our way of doing research, looking at the drawing and the representation techniques as media collaborating for a deeper knowledge. It is required a renewed focus on other forms of knowledge and of action, as well as a position of listening to the needs that are expressed by other actors involved in the design process. During this process the Representation field is involved as a dynamic agent, stimulating action and collecting instances, working to

produce ideas that, responsibly, must be evaluated and verified through a series of tests. In order to better operate, those checks ask for an ever higher quality and quantity of data.

Are there some advanced tips to improve the efficiency and effectiveness of this complex process? We will try to answer by addressing to topic issues such as the role of the use of digital technologies, evolved from more established practices and based on a systemic and relational approach. We examine the limits and the virtues, exploring new communication languages and investigating the diffusion levels [3]; while we are still working on it, we anticipate some evaluations that could be discussed, deriving new demands from the debate, surely an essential topic for future studies. [4]

Digital graphics processing has become standard practice in recent years: it is a compulsory stage in design today. On the other hand the tool is not considered equally efficient in reducing the risk of omissions and errors. The reasons are to be sought in the limitations of the software, such as for example the types of Computer Aided Design (CAD) applications used, largely employed for the production of two dimensional drawings. The inefficiency perceived by users is the direct consequence of a certain difficulty in using the tools compared to the simpler interfaces found for office automation. The division of a drawing into classes of layers has always been a topical argument for the standardisation of information and methods of use and always an important subject for study by international standards authorities. One of the most significant international models is that drawn up by the American Institute of Architects (AIA), the BS1192 standard for Great Britain, the French System Unitary de Communication (SUC) of the 1990s and the Swedish CAD Guidelines Bygghandiingar 90 - SIS 1999.

Although BIM software applications in current practice ensure results of a much higher standard than those of traditional two dimensional CAD software applications, structured use of them can further improve the conception and design processes as well as the construction and maintenance processes. Often the BIM concept is associated with a quicker method of virtual modelling, which definitely guarantees faster results and higher quality, but it is not yet able to fully unleash the potential which a database for data of a different nature inside it possesses.

Here too standards must be adopted: at this regards, we mention the National BIM Standards Committee (NBIMS), based on standards for the interoperability of data and on the relative taxonomies and they put the various information sets into hierarchies following an approach that is appreciably different from those of the past, including classification systems, guidelines and best practices. Today's construction scenario contains a plurality of positions behind which lie just as many cultures which represent different conceptual approaches to design.

This paper explores the capabilities of the latest languages (both the analytical and/or the synthetical ones) of the new methodologies, connected to the preparation of the architectural design.[5] These techniques, exploiting the opportunities offered by parametric calculations, improve the communication of content using correct information for the various levels of detail. The increasing complexity of the project actions, often shared by a plurality of subjects, must be highly coordinated.

So, there is therefore the Useful Drawing, [6] which is pragmatic and functional, whose results exceed the drawn architecture characterized by information systems organized in a database constantly interrogated and quickly changed. Here the updating processes foresee automatic controls, overcoming the traditional analogical representation forms, adapting themselves in more dynamic ways. In other words, it is therefore a less sequential Drawing, and a more relational one. Within this complex background, the many different facets of drawing and the language of graphics, a broader concept and perhaps a more preferable term here, are investigated. They are confirmed as agents of intellectual mediation, as a support for expression and also as dynamic cultural and evolving factors, which have frequently been adapted, to contribute to a renewed quality of the design process, thereby recovering a role of greater visibility and effective relevance.

According to this view, the representation role seems to have recovered a role of greater visibility and importance, regaining an effective general recognition that has substantiated the delicate function of communication, interpretation and criticism. The surplus value of BIM methodologies is in fact not only connected by the ability to handle graphical representations at different scales using a single three-dimensional model; moreover, it seems to answer to some urgent requests moved by the complexity of design and construction. In fact, this approach actively supports the engineering process relating professionals to each others in a new system, reforming the processing mode, requiring more explicit coordination of activities and procedures, particularly through the management of *parameters*.

2. The importance of being Parameter

At a time when professional practice is demanding increasingly specific competencies and extremely tight timescales, a tendency is emerging for software technologies to be used in a more deliberately structured

way, in a continual quest – one which is at times laborious, at others more fruitful – for procedural strategies that enable the use of shared platforms. At the same time, the market is responding by offering a large number of applications devised to resolve the various specific requirements. The term *parameter*, from which some of the considerations in this book are derived, assumes different connotations depending on the context in which it is applied. Whereas in mathematics it represents an arbitrary constant used in systems, formulae and equations, in a design environment it can take on other, different shades of meaning. This is a good opportunity, then, to unravel this terminological tangle: unlike parametric software, BIM object-oriented software has more in common with architectural design, where the internal libraries available are actually classified by building element type. So there are software applications in which the parameter is central to a system of associated dimensional relations and is given flexibility by procedures that facilitate not only the formal conception but also the changes occurring in the subsequent construction stages, which is fertile ground for experimenting with programming code. In other contexts, the same term refers to the control of a certain number of variables (geometrical, relational and other ones) that enable a particular process (design, construction, management, etc.) to be managed. [7]

For computer science, a parameter is a value that a function expects to receive in order to do its job. In other words, the function, the program itself and the operating system expect (values) and want to know (what to do), because the programmer has expressly envisaged that information be supplied for those purposes, i.e. by requiring that parameters be defined. In the familiar context of design software packages, the process of constructing relationships and generating objects via modelling procedures is often carried out using a programming environment provided within the individual applications that is known as scripting. This refers to a programming language available within a software application that enables it to be tailored from the inside, by customising the tools and creating new ones.

These tools have made functions available to designers that were previously inaccessible (or required special, complex operations), thus enhancing not only the modeling procedures but as a result also making it easier to use shared formats to exchange information. The purpose of this is to enable interoperability within the individual products. Both parametric and object-based software are moving toward this common objective, on parallel paths: For the former (in terms of the most authoritative names on the international scene), we are seeing new operating processes being developed in which the professional works closely with the programmers, creating tailored applications as and when required. As for object oriented software applied to the architectural design sector, the most effective use of software tools enables some procedures to be customized, as discussed earlier, through an ongoing search for shared methodologies for organizing the data that are managed by the system.

3. BIM: Building INFORMATION Modeling

Current technology has useful virtual alternatives to offer, then, such as the adoption of three-dimensional models for display, simulation, analysis and calculation purposes. If, on the one hand, there is a risk of making the control of some highly sensitive procedures more complex, on the other, the BIM approach, whose potential is yet to be fully realised, has the power to confine traditional CAD tools to the role of producing series of drawings. Although two-dimensional drawings are certainly able to convey the designer's intention, they are often blighted by errors, omissions or inconsistencies, which can easily be identified using automatable checks. It 's definitely a less poetic Drawing if compared to some representations of the past, but its contents are highly informative.

Although a host of design studies are taking an interest in these issues, few are using this methodology to best effect. These tools enable significant changes to be introduced throughout the traditional architectural design process; in particular, the benefits can be estimated using a multi-functional diagram that compares the effort made by professionals to produce the design documentation in the various phases of the process with the time required to do so. The diagram provides a comparison of the distribution of the technicians' efforts through the various phases in a traditional CAD environment (graph 3) with how it looks when basing the design process around the use of a BIM (graph 4). The impact of later alterations to the design can also be assessed: it can be seen that the effort needed to make these changes is equal to, if not greater than, the effort required in the initial decision-making stages (graph 1). What's more, the impact of the costs of the subsequent alterations increases exponentially throughout the process. To that end, it is useful to refer to the procedure proposed by Lachmi Khemlani [8] in which, as the author suggests, "[...] *minor variations from this sequence can occur from time to time, but the essence of it remains as shown*".

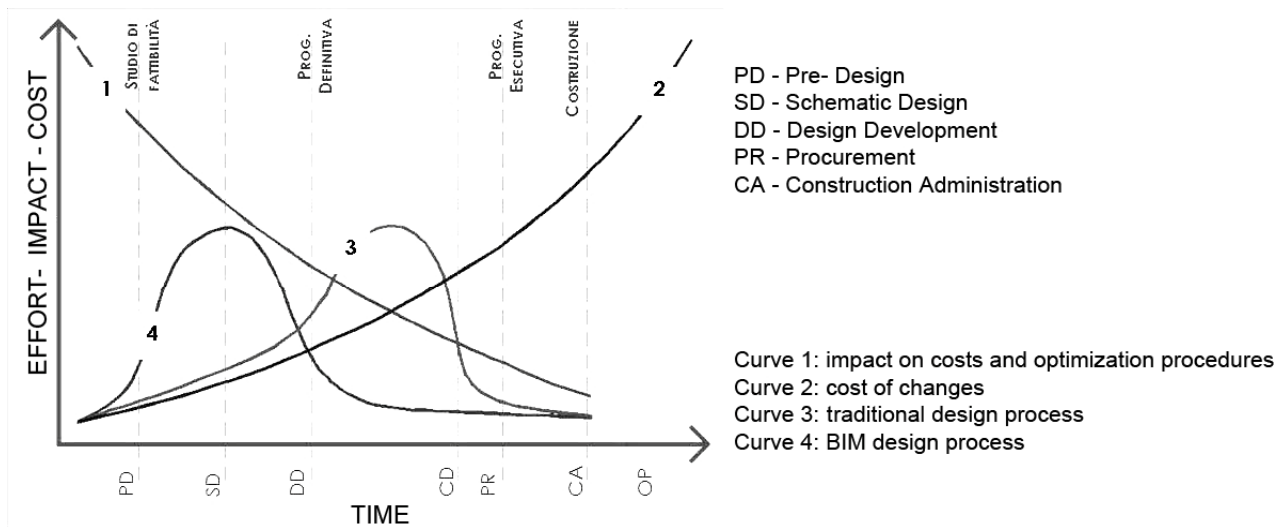


Fig. 1: Macleamy curve comparing the course of the current design process with the results of using a BIM approach in terms of effort, timescales and costs

In architecture, the process of progressive automation has taken and continues to take a path that is well-trodden in the history of the evolution of software, as most of the applications were primarily intended to support a process known as *Drafting*, including the initial forays into computer-aided drawing. The use of the third dimension in the representation of architectural designs and a systematic recourse to three-dimensional modelling have established a subsequent stage, known as *Modelling*.

The design process typical of the drafting stage is not affected by the use of three-dimensional modelling software, as the two-dimensional design phase is followed by a three-dimensional modelling phase, independently of the Monge representation. For this very reason, the three-dimensional model is very often developed outside the design team and only after the design development stage has been completed, as a natural “dead end” of the design process, one which is used only for the purposes of disseminating the design.

The process of progressive automation moved on with the introduction onto the market of the first “object-based” architectural software packages. Indeed, the introduction of the BEMs or Building Element Models, in place of abstract geometrical entities, represents the main step forward with the BIM philosophy: whereas the Drafting applications made possible the two- and three-dimensional geometrical representation of any architectural construction, the Modelling software applications make it possible to build it, albeit in the form of a virtual building. Hence the term *Designing*, for a tool dedicated to design in a completely innovative environment.

The automation of some of these processes will lead to the point when all the design information will be created and handled digitally, thus maximising the benefits of this new “virtual format”. In other words, we will have a digital model of a building, one that is not just geometrically accurate but can support completely different kinds of information. For this reason, the final stage is called *Collecting*, which corresponds to the design of the architectural construction in a purely BIM context. The introduction of BIM has brought a radical change in the management of the design process, and it is crucial to understand the impact that this has had, and will continue to have, in the construction industry. The very concept of the BIM is based on the possibility of incorporating meta-design information of a non-graphical nature, such as numerical and tabular data, into the 3D model.

Here the Drawing and the Representation roles are completely renovated, being able to coordinate and control the entire design process, through the management of complex procedures.

4. BEM: Building ELEMENT Model or Building ENGINEERED Modeling?

As previously stated, the BEM acronym stands for Building Element Models, a digital representation of the architectural elements that are introduced and used within the BIM environment for the creation of 3D models. At the same time we propose a new sense of BEM, in which the meaning of Element could be approached by the term *Engineered*, underlining the need for engineering process for new technologies, making them more efficient.

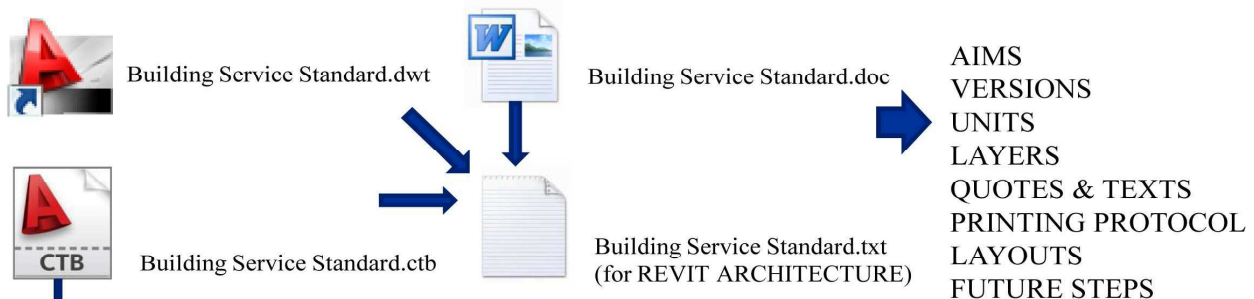
Information flows in the building industry to today are compared with the continuous return or feedback of that same information, given the need to relate different types of data to each other and take account of their reciprocal influence. The concept of “quality” in the building sector defines particular aspects of the building process for which a direct relationship between requirements and performance is necessary. At this regard, Drawing has always constituted a privileged means of communication, but the subject of “design as a measure of quality” does not end with the communication of the ideas or with the specification and verification of the ideas with regard to those who implement them.

The monolithic character of traditional building is flanked today by the requirement for an analytical dimension that can be broken down, the design of which results from the overlap and reciprocal coordination of the various sub-systems and the use of BIM tools seems to be the best answer to these requirements. We can talk of out-and-out codes for design drawings, constituted by a set of rules that allow to “regulate” the graphic data communication. Below there is a summary of the main procedures that maximize the concept of engineered model.

4.1 Process engineering and standardization of procedures: the case of the design of new student residences

The engineering procedure is well defined referring to the process performed to design of new university residences (Ministerial Announcement for the construction of new residences for students - Law n.338/2000, published in Official Journal, the 28th of April, 2011 n. 97). This case study is particularly interesting for the organization of work carried out by adopting standard codes, easy to understand and easy to use in order to effectively implement the dialogue among designers of different expertise.

In practice, it was drawn up prior document for the designing phase, greatly simplified compared to the international protocols, in order to capture two aims: firstly, to harmonize the procedural expertise to the same basic level, ensuring that professionals could adopt it in a shared environment; then, to update standards and procedures to those experienced in the BIM environment. Doing that, it is possible to enter and extract data from CAD applications, allowing less critical information workflows.



CAD Color	Printed color	Weight	% Filled	Contents
1 – Red	Black	0,1 mm	100%	Quote systems, layout
2 – Yellow	Black	0,1 mm	100%	Elevation lines, not sectioned lines
3 – Green	Black	0,15 mm	100%	Frames
4 - Cyan	Black	0,09 mm	100%	Sectioned Walls, Structures
5- Blue	Black	0,4 mm	100%	Ground line
6 – Magenta	Black	0,05 mm	90%	Furnitures
7 – Black	Black	0,1 mm	100%	Layout lines
8 – Dark grey	Black	0,05 mm	70%	Hatches
9 – Light grey	Black	0,05 mm	80%	Edile per impiantisti/linee molto sottili
10 – Red for Construction	Black	0,25 mm	100%	New elements
50 – Yellow for Demolition	Yellow	0,25 mm	100%	Demolished elements
Other colors	By color	0,4mm	100%	HVAC, electrical, plumbing systems

Fig. 2: Proposal for standardization protocols: the scheme summarizes the connection between CAD and BIM standard used for new architectural design of the Politecnico di Torino.

Shortly, the protocol includes a set of prescriptive guidelines that contain elements of unification for the management of the projects, specifically dedicated to its representation such as layout templates, layers, text size and pen thickness. We tried to use standardized naming and symbols, also available for CAD drawings and for the treatment of processed data in a BIM environment. Moreover, this work had as intermediate

target a gradual upgrade of staff training for the Building Service working group. The future goal is to extend BIM methodologies to all areas of design process. A radical change has seemed, at present, impractical, especially for those sectors that use CAD applications like graphical representations derived from computational algorithms run by other applications (as in the case of plant design).

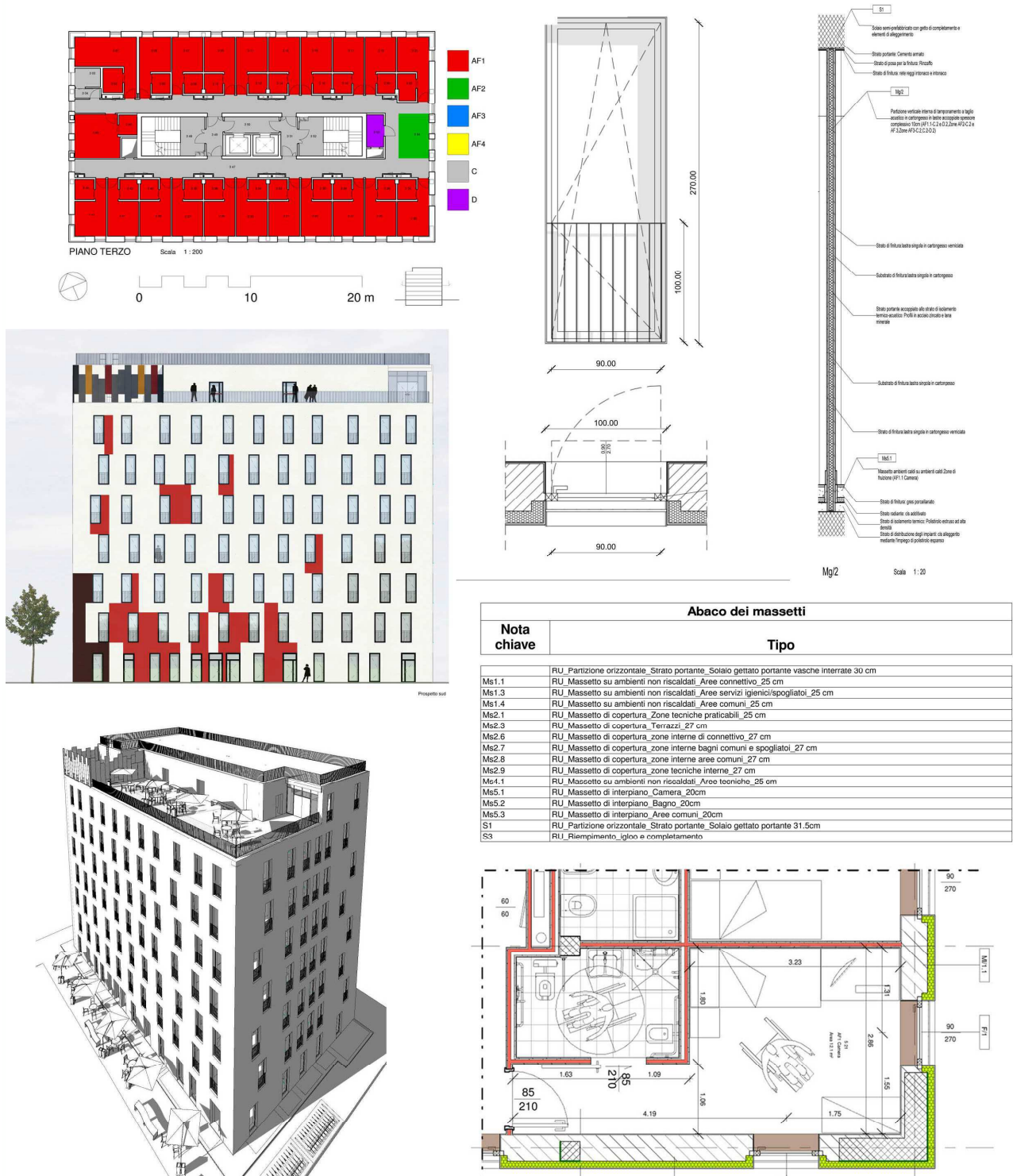


Fig.3. Different drawings taken from the 3D model: thematic drawings, 3D views, schedules and some details obtained from the BIM model. (Authors of the virtual model of the Codegone residence: eng. G. Cangialosi and eng. M. Lo Turco).

Even in these cases, which present specific and non interoperable information, procedures can be organized by adopting particular protocols, so as to guarantee the efficiency and effectiveness of technical communication.

Also within the BIM platform, the second topic was the adoption of various templates according to the different types of intervention (referring to different levels of design: master plan, preliminary, final or executive designs, new or existing buildings...). The time constraint seemed the perfect opportunity to put into practice certain procedures till now known only in theory.

The two design project, although characterized by different plan distributions, show remarkable similarities in relation to manufacturing technologies, components and building materials chosen for walls and floors, reducing the time used for drafting of construction details, quantity take-off and its evaluation of economic costs and exposure. From the operational efficiency viewpoint it is important to decide in advance the view models, such as the standards for the visualization of the project at different scales (1:200-1:100-1:50, in order to speed the transcription of drawings at different scales, equipped with some topics expressly required by the announcement. It was organized an information system based on relations between some parts and the entire design project, thanks to a graphic representation organized through a unique model. This methodology is destined to bear the complexity that occurs whenever it is needed to start from the conceptual phase up to the construction one, working as the product of data processing and, at the same time, being challenging and fascinating if collectively shared.

4.2 Teamwork: the case of the reutilization of a heating station into new classrooms

Each new project provides interesting ideas to carry some innovations in the working methodology, maintaining the desire of doing research and trying to compare results issued from previous experiences. In the mentioned case study, some areas will be converted into new classrooms; it was decided to adopt a working system that would allow multiple users to work concurrently, using the same file. The goals of the trial were to assess how and whether it was possible to:

- maximize efficiency production through adopting a coordinated and consistent BIM working approach;
- define the standards, settings and best practices that ensure high quality results and uniform drawing output across an entire project;
- ensure that digital BIM files are correctly structured, in order to enable efficient data sharing working in a collaborative environment.

There are several methods to enable collaborative working in a BIM environment, including working practices and team management. This topic deals with the principles of subdividing a model for the purposes of:

- multi-user access;
- operational efficiency on large projects;
- inter-disciplinary collaboration.

We must honestly remark that each project carries out a period of knowledge and testing able to improve the traditional workflow. Doing that, each new project means an improvement of the traditional workflow. Till now, the information sharing technology was done using external references (linking) in order to split the architectural part (Revit Architecture) from the structural one (Revit Structure).

The design of new classrooms was the ideal chance to progress in the trial: also in this case it was carried out on the basis of international experience, first of all the example of AEC (UK) BIM Standard for Revit, a workable implementation of the AEC (UK) BIM Standard for the Architectural, Engineering and Construction industry in the UK. This Standard is aligned with BS1192:2007 Collaborative Working, which defines the process for project collaboration and efficient data sharing. Focusing the attention on collaborative environments, we have defined specific processes aimed at effective data sharing in real time.

Regarding to this, the technology called Worksets allows multiple users to simultaneously make entry on a single template file, called central file, which is frequently updated by implementing multiple local copies.

The use of worksets is useful when the design phase is already far from the initial stages, in a phase in which it is requested the production of a significant amount of executive drawings that can hardly be quickly delivered by one person.

The work is then divided into different skills (structural, construction, engineering ones) so that the individual professional is responsible for a particular scope.

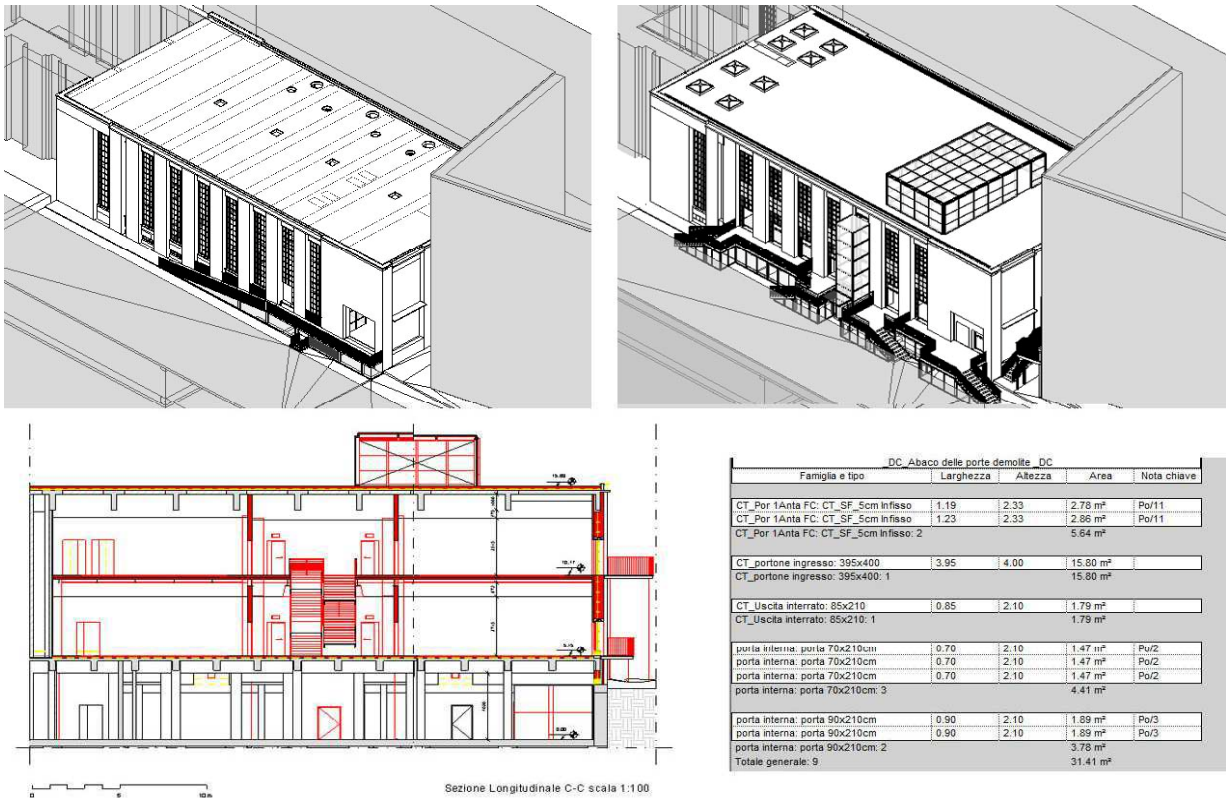


Fig.4. The variable time can be effectively managed within the BIM, as demonstrated by the following documents that compare the status of fact, the future project, demolition and construction section view and extract theme of schedule. (Authors of the virtual model of new classroom design: eng. G. Cangialosi and eng. M. Lo Turco).

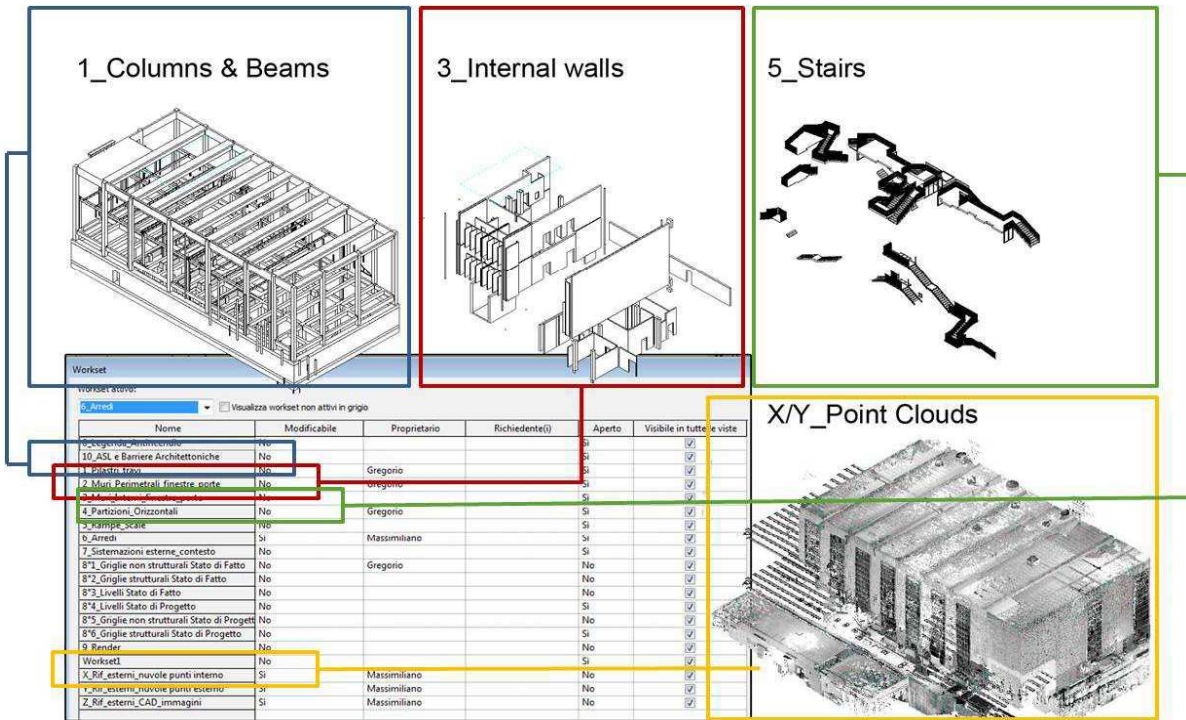


Fig.5. Through the workset management based on a set of simple rules that govern the interactions between the owner of a particular area (structures, walls, horizontal elements, point clouds,...) and some applicants, it is possible the current work using the same virtual model.

It is also possible to keep track of different changes applied to the model so that we can have a record of undertaken actions. This work is an excellent example of integration between the various professionals, both for the survey made by 35 laser scans directly imported into the parametric software, and for the planning, dividing the digital model into several worksets, as shown in fig.5.

5. Conclusion and future proposals

The adopted methodology has seemed very productive, as it has greatly reduced the design time and the number of errors, especially those related to interference between architectural and structural elements, (identified in both graphical and tabular views) contained within the shared platform. The most obvious benefit is the permanence of information of different nature: this is a topic element not only for the success of the design process but also for an equally controlled and organic process of management /maintenance.

As for purely design aspects, future versions of the standard are intended to enlarge the skills involved, including other actors, such as plant engineers, builders, contractors.

From the operational point of view, Politecnico di Torino created a dedicated department to deal with the integration of processes and information systems (known as IPSI), which, under the guidance of the Board of Directors, launched the Politecnico's Facility Management (FM) plan in autumn 2009.

The plan aims to optimise the management of the University's internal processes, by providing an information system containing the data on the various activities, thus creating a single database as a reference point for sourcing information and carrying out subsequent analyses.

It is a "time Drawing", able to handle a before, a during and an after, not only in the design process than with the capability of the database to be associated with design changes over the time. A drawing, therefore, apparently less iconic, but with strong information contents.

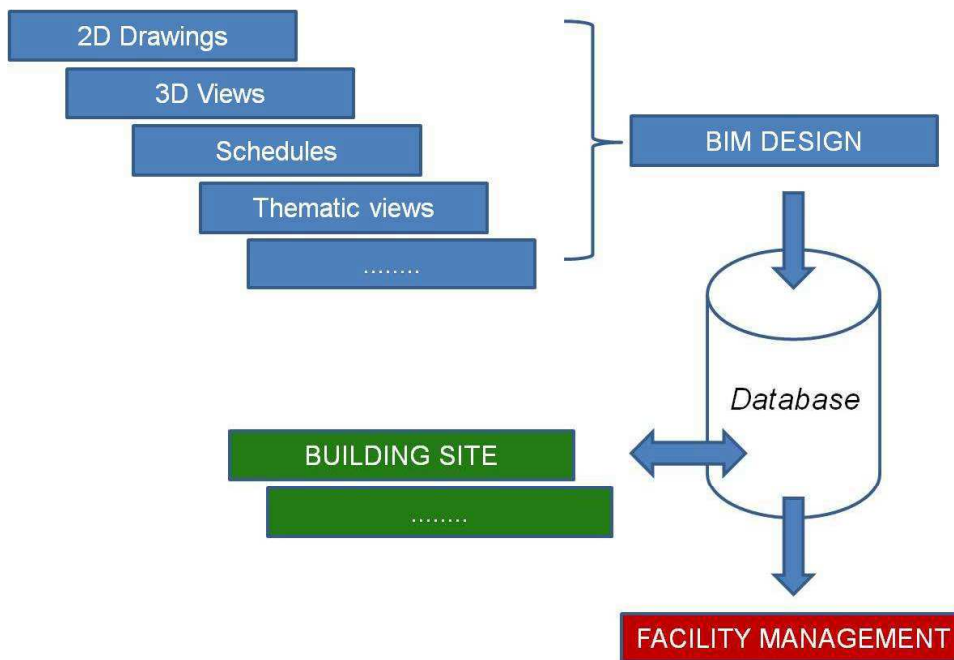


Fig.6. The diagram shows the main themes that constitute the design phase, ordered and managed by the database that is used again in the construction phase and for subsequent management applications.

The availability of an information system of this kind makes it possible not only to manage the data but also to devise and administer effective working and procedural processes. The technology can also be used in combination with BIM software and can facilitate an interoperable exchange of information between the two. For the FM project only, the basic virtual model will gradually replace the traditional CAD plans. This change will be no mean feat, as it will bring a real quantum leap in quality, one that will require the whole logistic area to adopt the BIM methodology. This change will encourage greater interaction between the parametric software systems and the FM applications, such that all the analyses can be carried out against linkable data, thus ensuring greater control over the processes and eventually enabling full data interoperability to be achieved. [9]



Finally, the methodology represents a new way of thinking about Drawing, in a fresh and renewed role, which organizes, arranges and manages a multitude of possible representations, constantly comparable: so, data sharing of different expertises enrich the relational database proper of the new systems.

References

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