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TERRITORIES AND FRONTIERS OF REPRESENTATION

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The articles published have been subjected to double blind peer review, which entails selection by at least two international experts on specific topics.
For Issue No.2/2018, the evaluation of contributions has been entrusted to the following referees:
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TERRITORIES AND FRONTIERS OF REPRESENTATION

Territories and Frontiers of Drawing

Interpret the identity issues of drawing based on the relationship between past, present and future.

Editorial

Vito Cardone

Last year, just a few days before Christmas, Rony Abovitz's startup *Magic Leap* finally presented something concrete in regards to the mysterious, so-called 'mixed reality,' said to surpass both virtual reality and augmented reality. The company has been working on the project since 2011, in Florida, in great secrecy and with huge capital-risk financing by some of the major companies in the digital world, among others (more than two billion dollars have been raised to date). Basically, this revelation raised only a corner of the veil which, up to then, had hidden the invention, of which only a few bits of advance information, well-crafted to arouse curiosity and interest, had previously been disclosed. The headset was tested in advance by *Rolling Stone* magazine and additional images were made available on YouTube, where they had been cleverly doled out for some time. In fact, it is appropriate to say, the product still remains mysterious. The company maintains that it should forego computers, PCs, tablets, smartphones and similar devices, only using a headset, resembling goggles and worn like a pair of glasses, capable of making virtual images appear in the real world with the projection of a digital light field towards the eyes of the observer. It has been confirmed that the product should be available within 2018, but the precise release date and price are still unknown.

Interest is enormous because, if it keeps its promises, the invention should be truly revolutionary and open a new era in computerized representation, going beyond the current frontiers of visual representation. The fact is that, after the revolution generated by the introduction of infographics, profound innovation in the field of visual representation has been marking the pace for almost a quarter of a century: an enormous length of time, con-

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sidering the accelerated pace that now characterizes technological progress. This period of stasis, however, has been beneficial, because it has allowed users –including academics and technicians– to not pursue incessant and portentous transformations, to acquire the incredible innovations introduced, to metabolize them, and then to use them with competence and profound mastery. It has also contextualized the new procedures, placing them in the role and dimension that they actually possess, depriving many of the aura of the scientific aura that at the beginning some attributed even to their simple use, without any critical contribution that would lead to their improvement, without any contribution to their implementation and to the full development of their enormous potential.
In fact, for years, in Italy and abroad, in the field of graphical representation they have been utilized, above all, for the rapidity of operations; the automatic registration of variants, wherever they are made, in the entire electronic model; the potentiality of virtual or material modeling, based on data collected with laser equipment or the result of a design concept pursued, even directly, with dedicated software. The suggestions related to the possibilities of application in fields not previously cultivated by experts in the sector has allowed us, in any case, to go beyond the representation of architecture, of civil engineering works and of the territory, to deal with, for example, statuary, musealization, the processing of images for communication and educational purposes, just to mention some of the themes in which we have been more involved. This has also entailed the advantage of favoring relations with other scientific-disciplinary areas, even the humanities, and therefore multidisciplinary work, even in very heterogeneous groups. The basic scientific contents, those that should characterize the specificity of the area, have not seen any further enrichment or evolution, after a certain progress following the infographics breakthrough. To use the words of the theme of the UID Convention held in Naples, Italy, to which this issue of the journal is dedicated, after the shifting of the frontiers related to infographics, the territories of graphic representation have expanded; new fields have been cultivated, which have produced unprecedented and important fruits and are still very promising. Productivity, however, has been progressively decreasing; the ferment that at the beginning characterized the entire scientific community is ending and we are starting to see that *routine* work, devoid of any really innovative ideas, is becoming more and more widespread. All this emerged with great evidence from the papers received for the Naples Conference, whose theme was *Territories and Frontiers of Representation*. A current theme which, while unequivocally disciplinary-specific, became harbinger of a broad reflection on the question of images in architecture, art, science, technology and society in general. The territories of representation are in fact numerous –including those of science, technology, art in its innumerable manifestations, but also those of pedagogy, education, teaching and learning– and extremely vast, if not actually unlimited. Architectural and environmental representation occupies only a few chapters of the more general question of visual representation, which interests humanity and includes the representation of bodies, of space (not only architectural or urban), of the earth and its characteristics, manifestations and phenomena (geology, flora, fauna, anthropization), of ideas, of imagination: in a word, of the universe in which they are born and develop.
In many cases, these territories are intersecting, overlapping and intertwined, in a way that is not easily understood. They are boundless, because representation has no frontiers or, which is actually the same thing, if boundaries are set up, they can only be temporary and provisional, fragile and yielding, penetrable and dynamic, continuously movable. Often there are new spaces beyond them to be cultivated, new territories to be rendered fertile and in which to test one's identity, with the risk –or luck, if we place ourselves in broad temporal projections– to see it transformed. However, surpassing boundaries is the only way to continue a productive and meaningful journey, avoiding the risk of remaining in a static situation, a stasis, which soon turns to decay.
This applies to all fields of knowledge and art. Not by chance, *Beyond Borders* was the title of the 2017 Turin International Book Fair, whose official poster showed the image of a book straddling a border wall. And the next annual UID conference (Milan 2018), focused on representation of the material and the immaterial, should also reach well beyond borders.
In reality, this year the theme of the Conference should simply have been *Frontiers of Representation*, but due to the negative meaning that, in the pernicious drift that the so-called 'civil society' has taken in regards to human values, many attribute to this first term, some of us proposed to adopt the word 'Territories' as well. Thus a very ample theme was outlined, which has fully responded to the need, manifested forcefully in recent years, to give all colleagues from our field the opportunity of submitting a contribution.

Consequently, this has led to a considerable increase in the number of papers being submitted, allowing us to continue to have (as, for the first time, in the previous Conference held in Florence, Italy) a wide and significant overview of the scientific production of the entire scientific-disciplinary sector.
Following the call, as many as 300 abstracts were received; after the double-blind peer review, to which both the abstracts and the complete versions of those received were submitted, 224 papers were accepted: as many as in Florence. One-fifth of the authors were foreigners, finally no longer just Spaniards and Argentinians, but from 12 different countries. This fact, also considering some papers written in collaboration by Italians and foreigners, allowed a broader comparison of experiences, in comparison to previous years, and can allow us to speak of a truly international Conference.
The range of topics covered was very extensive: from more traditional ones to others certainly more original, innovative or simply uncommon for our field. A fairly broad critical summary of them is found in the *Preface* to the Proceedings of the Conference. This issue of the journal offers only a glimpse of the most significant contributions. For each *Focus*, the extended version of the introductory report and two papers are being published, selected among those that achieved the highest ratings from the conference referees, and on the basis of a further referral for which a new long abstract was requested from the authors of these contributions. The opening address was instead dedicated to Anna Sgrosso, who was awarded the 2017 UID Gold Medal.
Here it is only appropriate to note that once again, the greatest number of contributions dealt with surveying, in its various and, for us, traditional forms –architectural, urban, territorial, archaeological– to which has been added, to a not inconsiderable extent, the survey of individual artifacts, whether archaeological or sculptural. This testifies that surveying continues to be the major aspect of our commitment to applied research, in some cases linked to important agreements and third parties and sometimes an occasion for the most intense interdisciplinary relationships. Conducted everywhere with the use of the most advanced methodologies and instruments, it is often carried out on artifacts which have already been surveyed several times, finding errors and limitations in the existing documentation, and helping to correct and integrate it. However, in numerous cases, these surveys are not truly critical, performed by applying sophisticated tools and software, without questioning, as they should, the limits, the approximations of the operations and the results, from which such procedures are not immune. In other cases, on the contrary, due attention is paid to these crucial aspects –which are not only technical and operational– without, however, posing problems of critical reading and interpretation of the artifact, but dedicated only to the graphic restitution of its morphology: something more suited to topographers. Ultimately the clear impression is given that there has not yet been well defined and confirmed, in these long years of generalized adoption of the new digital surveying procedures, a sort of synthesis between the two approaches, which would perhaps be the path to pursue for our sector. More intriguing, with much broader perspectives, seems the most recent interest in the surveying of archaeological finds and sculptural elements, which was the main *focus* of various contributions. In confirmation of what was said earlier, contributions of a general theoretical nature, which the theme of the Conference should have solicited, instead decreased. The commitment to geometry, in particular, manifested itself, above all, with contributions on traditional themes, investigated with new technologies and procedures, still without any significant exploration in the territories opened by the infographic revolution.
Teaching is another topic that aroused great interest, with numerous contributions centered on the fundamental and inseparable relationship with research. Some from this field ventured near some stretches of the frontier, or rather, the old frontier: for example, in dealing with online education –a thorny issue, previously almost always avoided– and that in academic areas is distinct from architecture, design and engineering.
Sometimes, however –as in some studies on territorial and urban representation by several participants, mostly Argentinian, Brazilian and Spanish– great emphasis was placed on the frontier of representation, beyond which boundless prairies are seen, in which some of the possible and desirable paths for future developments in the scientific-disciplinary area are recognized. Someone even crossed the artificial border and courageously explored unknown territories; others gave tremulous glances, unsure of what to do; too many, instead, stayed in safe territory, sometimes in strongholds, as on the edge of the desert of the Tartars, from which they showed no intention of distancing themselves.

My hope is that the thematic issues of *diségno* can help to change this situation. In fact, the task of a journal like ours is not just to be a showcase of applied research, well packaged, conducted and presented, without significant attempts at innovation, but above all that of helping to create the conditions for everyone to arise and embark on the mysterious and obscure paths of scientific research, even avantgarde, or as an end in itself.
Some themes crossed, met with or were met by various *Focuses*, which confirms that not even topics have rigid boundaries. These include those related to virtual models, virtual reality and augmented reality, visualization and modeling: as though to testify that it is now –as in the past with computer graphics– above all a question of acquired operational tools or general languages, more than specific themes.

The impression has emerged that there are some topics (those of *Focus 4*, for example) that we are still not always able to frame appropriately: neither from the standpoint of their presentation, nor as revisions. The quality of the reviews is a serious problem, which also concerns review of the articles: in the one case, as in the other, often carried out with an approach worthier of censors, as a judgment of absolute value for assigning 'accepted' or 'rejected' rather than a moment of a complicated and complex process aimed at improving the quality of the product: that is, a laborious work of support and orientation of reviewing.
For this reason, we have decided to publish the form created for the reviews of the complete articles on the website of *diségno*, hoping that this will help the authors to improve the development of their proposals, and the reviewers, the quality of their work.

Geometry, Space, Configuration: a Meeting with Anna Sgrosso

Agostino De Rosa, Andrea Giordano

During the last Congress of the *Unione Italiana per il Disegno*, held in Naples, the *2017 UID Gold Medal* was awarded to Anna Sgrosso with the aim of rewarding the complex of scientific and cultural activities promoted at the University of Naples Federico II over a long and prestigious career. Thanks to her studies, both in architectural and mathematical fields, Anna Sgrosso has revitalized Descriptive Geometry, finding new expressive and communicative impulse in the study of its projective roots and in the links that this discipline establishes with the world of figuration and art.
In particular, Anna Sgrosso's proposal to use traditional representation systems (Monge, axonometry, perspective) in an unconventional manner led to an innovative interpretation of architecture –realized or in progress–, in which it is possible to identify structure and geometric genesis of the spaces. But the great passion for drawing of professor Sgrosso also emerges from the unconditional endeavor generously given in teaching activities at the Neapolitan faculty of architecture, where she trained entire ranks of students who still today show affection and gratitude towards her. Perhaps this is the most correct key for interpreting his extraordinary professional success! Although Anna has been busy over the years in important cultural, institutional and managerial commitments, she has not spared herself

Articolo a invito a commento della Lectio Magistralis di Anna Sgrosso, non sottoposto a revisione anonima, pubblicato con responsabilità della direzione.

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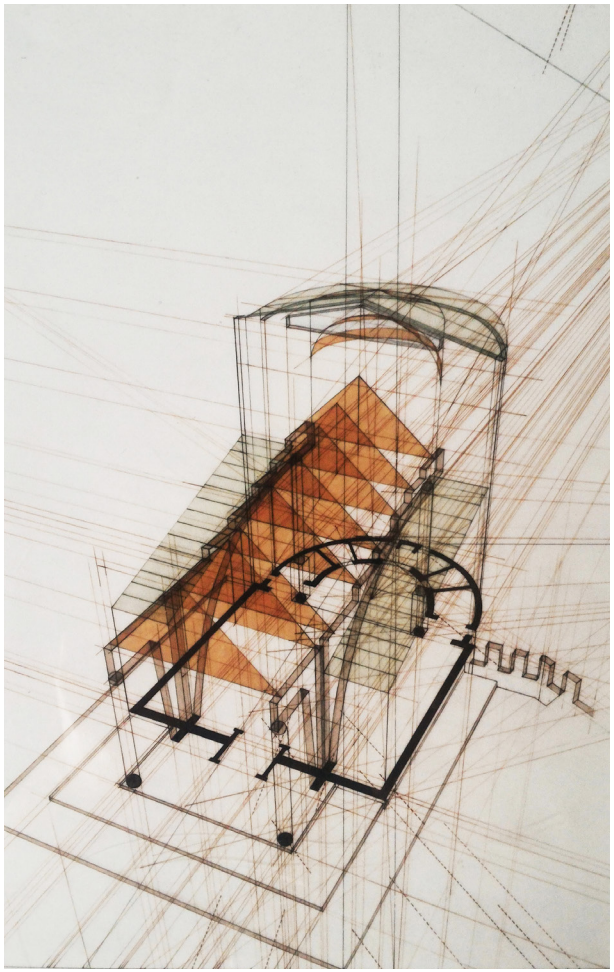
in didactic field, fusing scientific rigor with an extraordinary humanity. So, we can say with certainty that Anna Sgrosso founded a 'school', whose students are now teachers in many Italian universities, spreading her research and training methodologies, as well as her critical studies, throughout the country.

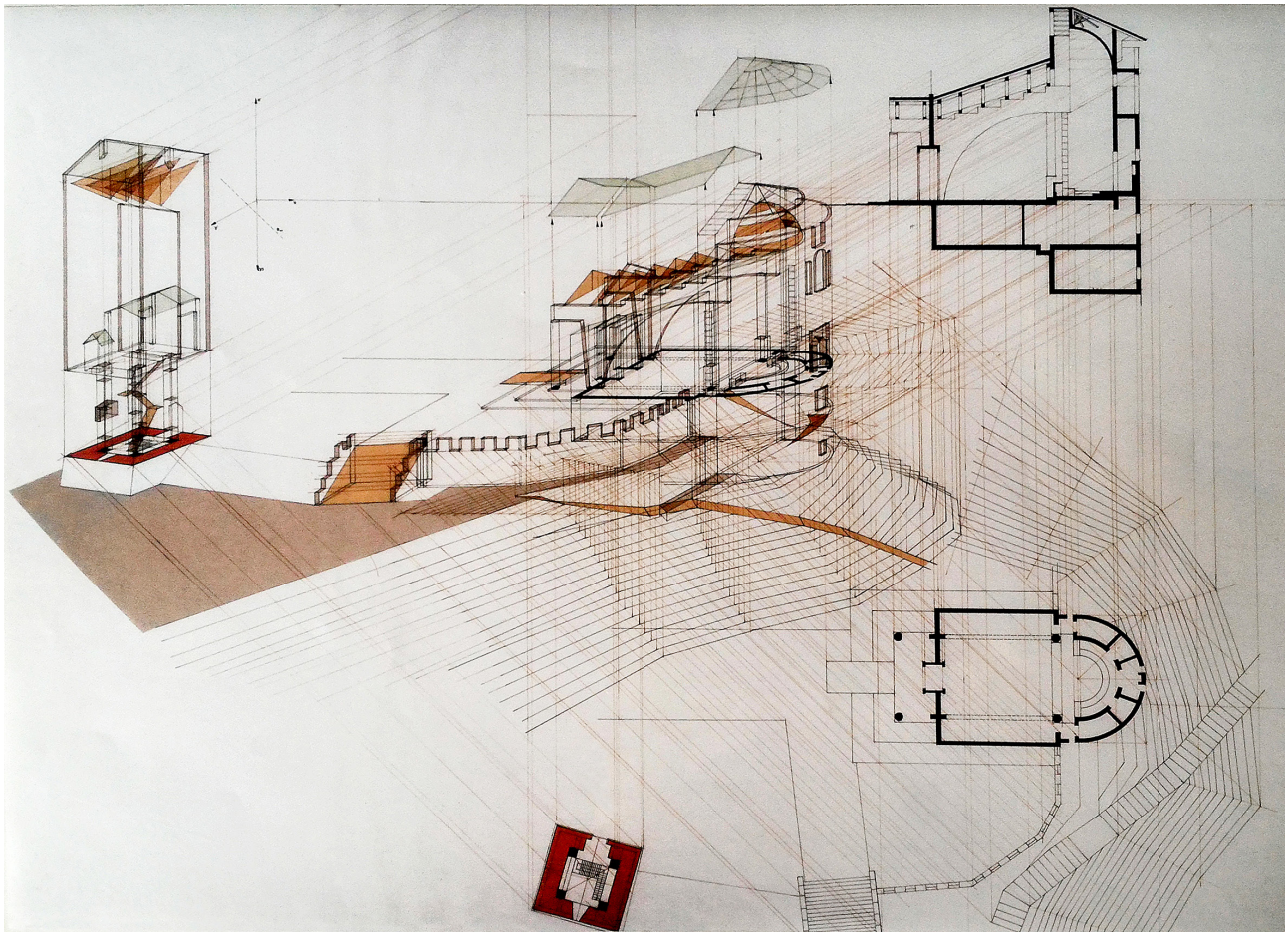
Fig. 1. A. Romano Burelli (with P. Gennaro) Saint Helena Empress Church, Montenars. Bird's eye perspective. Drawing by Alessandra Pagliano.



At the end of December 2017, the authors of these pages, as her former students, met Anna Sgrosso at her home, a place assiduously frequented during the last twenty years, not only for reasons of study but also for sincere affection. Reference master and scholar, but above all dear friend, even on that occasion Anna confirmed her incredible charisma: talking with her means facing a journey into memory, full of hilarious but also dramatic episodes. Indeed, During the conversation, several issues were addressed, such as the one concerning the situation of the Napolitanean *cursus studiorum* in architecture at the time of her degree –it was the year 1950 and *'la'* Sgrosso was one of the first women that graduates in architecture at the Federico II University in Naples after the Second World War– especially in relation to the disciplines of drawing. Anna was, then, 'voluntary assistant' in the *Descriptive Geometry* course held by professor Mario Giovanardi: the described situation also included the course of drawing from life. However, in the teaching system following the First World War (specifically in the academic year 1928-1929) the course of *Live Drawing* and that of *Descriptive Geometry* did not exist; only one *Figure and Ornate Drawing* course were established, held up to the A.Y. 1935-1936, when they were replaced by the course of *Live Drawing I*, followed, at the second year, by the course of *Live Drawing II*. This situation lasted until the A.Y. 1969-1970. The course of *Descriptive Geometry*, established in the A.Y. 1932-1933, will then take the title *Descriptive Geometry and Elements of Projective Geometry* (from 1935-1936), keeping it until 1969, when DPR No. 995 of 31.10.1969 was issued in relation to the reorganization of the studies of the faculty of architecture, and *Descriptive Geometry* comes back to this simplest denomination, placing the *Applications of Descriptive Geometry* at the second year. At a certain point the first of the two geometry courses is closed because the second one, the *Applications*, is considered sufficient; but to avoid a lack of knowledge and therefore learning difficulties, the main concepts of the first course will be reported at the second year. It is precisely Anna Sgrosso who proposes, at a national level, to name that course *Fundamentals and Applications of Descriptive Geometry*, as: "it would have been absurd to teach 'applications' of a subject whose theory is not known!" [1]. Among these applications photogrammetry would have been included. Other fundamental disciplines will be *Drawing and Survey* at the first year, replacing the *Live Drawing I*.
The first teaching experiences in Descriptive Geometry and its applications, in Naples, therefore passed through

Anna's work with some key figures: Mario Curzio, Mario Giovanardi, Rodolfo Permutti, and Maria Miglio. The experience made in particular with Permutti and Miglio is fundamental for Anna Sgrosso who considers them: "both extraordinary people, even if in a different way".
During the conversation, when we attribute to her the birth of the so-called 'Neapolitan school' of Descriptive Geometry as a science of representation applied to architectural configurations, Anna replies: "And does it seem strange to you? Won't it be because I am an architect? However I did not know at all that I had even founded a 'school'! And if this is true, of course I'm happy". Regarding the scientific approach, it must be recognized how the frequentation of the institute of mathematics on the one hand helped her preparation, on the other, it subverted teaching and interrogation methods during the examination, it was not usual

Fig. 2. A. Romano Burelli (with P. Gennaro) Saint Helena Empress Church, Montenars. Configurative representation of the building: Cavalier axonometric projection. Drawing by Alessandra Pagliano.



to ask students 'why' referring to statements recited often in a mechanical way; this pushed towards the understanding of the *ratio* that precedes every algorithm. Her scientific approach also has specific implications in teaching, while Anna refers to: "clarity and precision, above all in 'doing' lesson!", on the other hand, she remembers how, during the *Drawing and Survey* course, which she held for several years, she was even able to amuse the students; indeed, Anna had 'invented' an original way of analyzing buildings –already surveyed and represented following the canonical methods of Descriptive Geometry (Monge, perspective and/or axonometry)– advising students to go further in translating architecture into an 'exploded axonometry' that privileges a configurative reading. With this suggestion she meant an image of the building in which to eliminate the thicknesses of walls and stairs, so that in the new images only the edges remained: in this way exterior and interior would have emerged together. The final drawign would have been not only more readable, but also more 'elegant'. In reference to this kind of abstract analysis, la Sgrosso recalls an extraordinary experience performed in the academic year 1981-1982, that is immediately after the serious earthquake that devastated Irpinia on November 23th, 1980. Following the disaster, a group of teachers stipulated an agreement between the University of Naples (not yet split in the two universities) and the municipality of Gesualdo –a small but beautiful town that had suffered serious damage– with the title *L'Università per Gesualdo* and the subtitle *Un impegno di idee e di progetti per la ricostruzione e lo sviluppo del dopoterremoto* [Caterina, Gangemi 1985].
To this initiative, and at the precise request of the proponents, Anna Sgrosso adhered with great interest as a teacher of *Drawing and Survey*; each (the other teachers of the group belonged to different disciplines) would have offered their contribution to the reconstruction of those towns. Being a perfect knowledge of the site necessary, evidently obtained through a careful survey of the entire inhabited area, the work of Anna: "imposed itself as first operation to do". For this reason, it was formed a working team composed by students, to whom the survey of Gesualdo was proposed as exam theme of the year: "but not before asking whether a good number of them wanted to follow me up there, for the necessary operations […]. Instead all the students enthusiastically adhered to that initiative". The outcomes of this survey was published on the mentioned text with the title *Il rilievo: analisi di forme e sintesi di strutture*. This contribution, in addition to a detailed description of the site and the methodology adopted for the effective construction of images, collects the graphs performed by the students, together with photographic images, in particular those related to: "the splendid sculptural details that decorated the portals of the houses". But the same pages also show the innovative interpretations that Anna defines: "configurative-structural representations", readings of architecture, in transparency and without thickness of the walls, that highlight, in a sort of *ante litteram* wireframe, the paths, the connections and the geometric-structural matrices of the buildings. In the Sgrosso's vast scientific production there is a constant interest in the term 'structure', aimed at examining the building as meta-text and linguistic form: in this sense, Sgrosso refers to coeval research contexts on semiotics, in particular to studies by Renato De Fusco, with whom she establishes a certain convergence of interests on the architectural phenomenon. Anna Sgrosso recalls a conversation with De Fusco about the concept of space, a theme on which she was writing an essay: "Renato seemed very interested in this subject, so much to publish the text *Topologia e architettura*– in the magazine *Op. Cit.*, which he directed, even as the first essay of that number" [Sgrosso 1979]. In this regard, Anna clarifies that topology, which has always been one of the subject of mathematical studies, introduces, alongside traditional geometry –which in the architectural project plays an essential role– a new concept of space, considering it in the sense of 'place' (from '*topos*'), stating that: "The resulting methodology brings to a meta-formal approach, aimed for abstracting from the architectural structure, going beyond the tangible data (which remain within the Euclidean geometry), its most real and intimate essence that could be defined precisely with the term of 'meta-form'.
It is therefore clear that Anna Sgrosso's contribution appears to oscillate between two poles: on the one hand, the study of the projective rules of images, on the other the historical study of methods and forms of representation. If we analyze her scientific production, her fundamental contribution to both thematic areas is evident. In particular, in 1984, Anna published a small book, a forerunner of the vast editorial project on the history of methods of representation [De Rosa, Sgrosso, Giordano 2000-2002]. This is *Il problema della rappresentazione dello spazio attraverso i tempi* [Sgrosso 1969], of which we report below the introduction, first because the covered topics are extremely present in some researches of our disciplinary sector, and second because the concept of space is articulated with great lucidity.

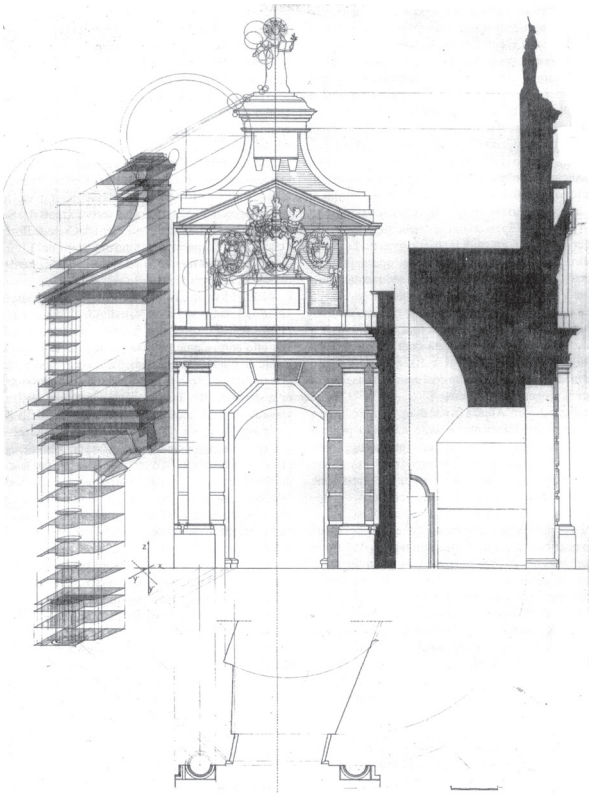
This introduction constitutes a unique synthesis for the times, which usually tended to delineate the development of methods through the interpretative key of geometrization. The same issue had already been addressed by others, previously, but never so broadly in terms of the historical interval examined.

On geometry and space

The following text is a translation of an excerpt from the introduction to the Anna Sgrosso's book entitled Il problema della rappresentazione dello spazio attraverso i tempi, published by Stabilimento poligrafico I.E.M., Casoria, in 1969.

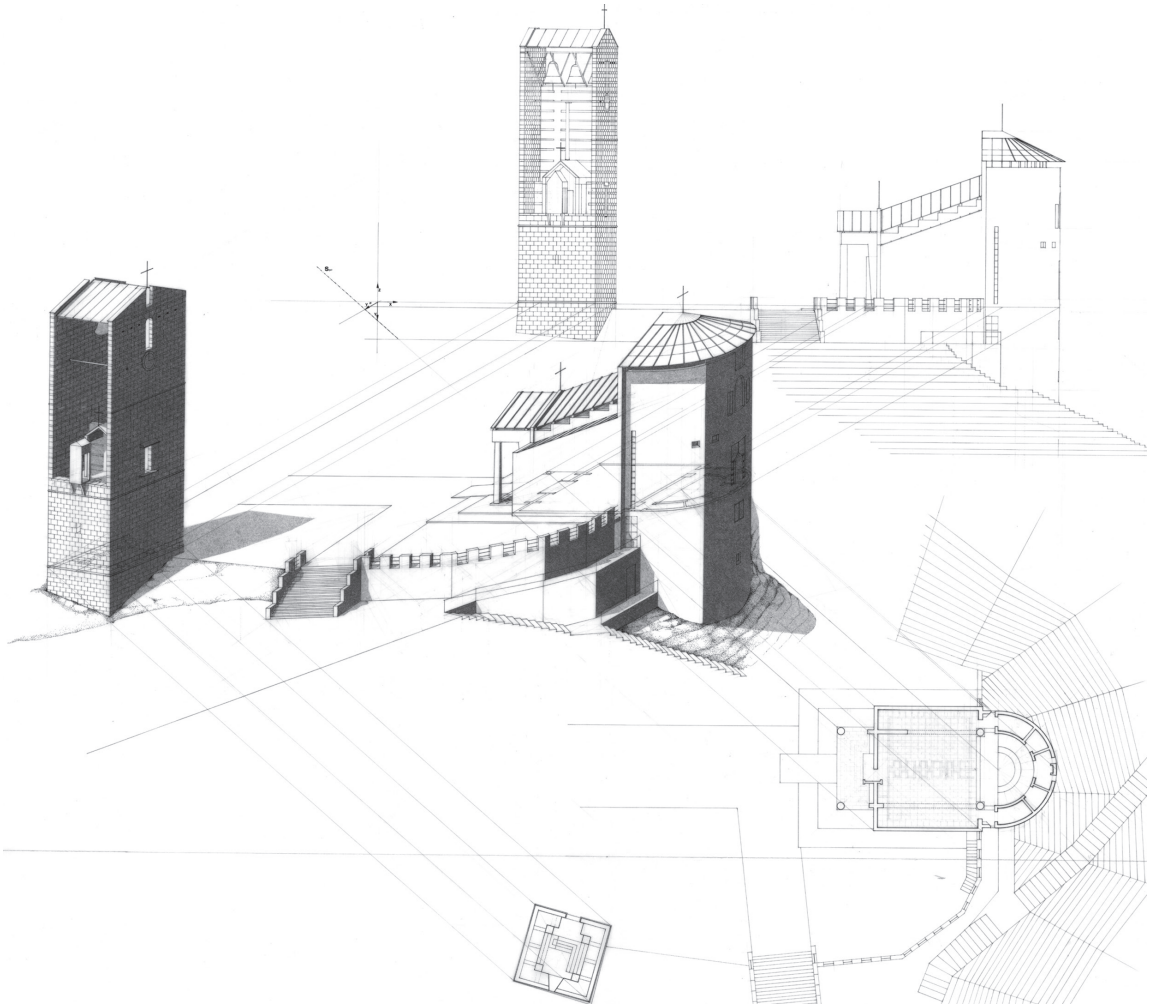
The concept of space structure assumes today a decisive weight and a precise role in the dialectic between figurative arts and mathematical sciences, while the research for a definition and characterization of the same space dates back to the time of Greek civilization and it is intimately connected to the great mathematical-physical discoveries, as well as to the positions reached by philosophical theories.
However, a precise definition of space concept has not yet been formulated, although its properties have been postulated: space is isotropic, homogeneous, infinite, so it is also measurable; but its three-dimensionality: "appears as an accidental configuration justified only by experience" [Jammer 1963, p. 164].
The research for a conceptual construction of space therefore poses both the problem of the physiological perception of the space itself, and that of its representation. So, Perception and representation are closely linked in the same expressive process; but the research for a spatial representation coincides with the research for the means to achieve it. These means, offered rigorously, or sometimes empirically, by geometry, constitute choices made in a given direction according to the dominant tendencies of every historical epoch.
Today the problem of representation appears intimately linked to linear perspective, above all because of the enormous diffusion of the photographic medium, which seems to confirm its validity. In reality, the representation-perspective binomial limits the very meaning of geometry, falsifying its role and giving it a weight different from the actual one.
The choice of a particular representative methodology must be consistent with the mathematical philosophical thought of its time: the figurative arts, in which this thought is reflected, therefore have an important part in this selective process. But when this consistency is lacking, a phase of rupture is determined, characterized by the rejection of the methods hitherto adopted and the research for others more responsive methods to new needs.
When the revolution of modern art began with the Impressionists, the rejection of the rigid schemes then dominant began, and the alternatives that were proposed took on a precise, though not definitive, dimension. After various experiences, which can be considered otherwise attempts of breaking up, the research in the pictorial field has become more and more decisive towards the rejection

Fig. 3. Alba city gate, Naples, geometric and structural representarion of the city gate. Drawing by Andrea Giordano.



of the geometric representation of space, that was, then, emptied of all its ideological meaning and crystallized in too strict constraints.
On the other hand, while the profound and radical changes undergone by mathematics extend the field of its operations and deductions, geometry today is no longer today able to provide an equally valid code, as linear perspective did during the Renaissance, also if it, even with the advent of projective, had opened many roads to pure inquiry and a large number of applications.
In this way we are witnessing the figurative research of new representative means more responsive to the modern

Fig. 4. A. Romano Burelli (with P. Gennaro) Saint Helena Empress Church, Montenars. Shade and Shadows applied to a Cavalier axonometric projection. Drawing by Alessandra Pagliano.



concept of spatial structure, and on the other hand to a new direction of mathematical studies: such studies, however, seem strangely to ignore geometry. This can partly be explained by the advent of a new theory which, polarizing the interest of researchers in a precise direction, neglects the other branches of mathematics or at least those that are not, or do not seem, likely to benefit from new ideas.
To the geometry and consequently to the perspective, today only the role of providing the technical means has remained, after all these means have been already challenged even at the level of simple representation, not only pictorial, to define spatial configurations.
The problem thus assumes a new dimension: geometry, lost its value as an object of study and research, it is no longer able, now, to provide a satisfactory code that is appropriate to new needs; but the total rejection of its methods, without the proposition of a valid alternative, determines as a logical consequence only the aggravation of today's state of crisis.
The methodological revolution of the figurative arts and the revolution of abstract mathematical procedures have not found their equivalent in geometry: but the need for the retrieval of new representative code does not, in my opinion, exclude research in the geometric field. I think, on the contrary, that the efforts of the researchers must converge in this direction, because geometry can and must be the instrument capable of providing this code.
It is therefore necessary to return to this discipline, its true meaning and its more specific function: geometry, is among all sciences, the most suitable to act as a means in the dialectical exchange between art and mathematics.
The rejection of certain geometric constructions does not necessarily imply the total rejection of geometry: the figurative space has today taken on a particular semantic meaning, as a synthesis of two moments, form and content, geometry and myth. If certain traditional relationships are therefore no longer acceptable, this only means that certain positions of geometry can be overcome, such as the Euclidean ones: but precisely according to the concept of space structure, it is always through geometry that new kind of links must be researched, because these new links are able to formulate a truly current representative code. However, to make sure that geometry assumes its specific role, a preliminary investigation is necessary, in order to highlight the reasons that deprived it of its primitive meaning: and this investigation can only take place through the analysis of the historical and evolutionary process of representation.

Notes

[1] Anna Sgrosso's direct statements are reported in this text as quotations. They are words gathered during our conversations with her.

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Project for a Sculpture

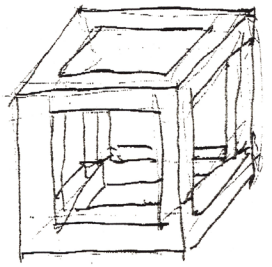
Sol LeWitt, Bruno Corà

1995-03-24 09:44 P.02
DEC-02-1111 08:06 FROM LEWITT TO 01139683640269 P.01

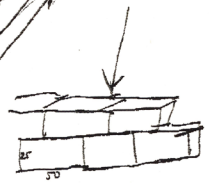
22/3

Sol LeWitt
20 Pratt St.
Chester Connecticut
06412
Tel. 203 526-4236
(Studio) Tel. 203 526 0312
Fax 203 526 2865

DEAR BRUNO
I AM SENDING A MAQUETTE OF A PIECE FOR PERUGIA. HOWEVER, IT CAN NOT BE MADE BY STUDENTS. IT MUST BE DONE BY MURATORI IT IS AN OPEN CUBE MADE OF CONCRETE BLOCKS 25X25X50 CM



IT IS A SIMPLE PIECE BUT IT WOULD TAKE EXPERIENCED MURATORI TO BUILD.



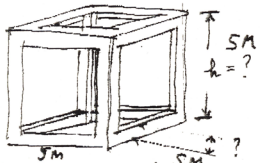
SOL

DEC-04-1111 06:19 FROM LEWITT TO 01139755730532 P.01

ACCADEMIA DI BELLE ARTI PIETRO VANNUCCI PERUGIA

23/3/95

Dear Sol,
Thank you very much of your sketch of the open cube for Perugia!
I understand the necessity that the work must be made by MURATORI or!
I wait the maquette with the measures (dimension, highness, thickness etc.)



SIZE OF BRICK

All the best!
Bruno

SOL

06123 Perugia - Piazza S. Francesco al Prato, 5 - Tel. 075/5730631 - Fax 075/5730632

TOTAL P.01

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Sol LeWitt. The Conceptuality of Drawing

Paolo Belardi

Two significant faxes can be found in the archive of the 'Pietro Vannucci' Academy of Fine Arts in Perugia: they are worthy of note both because they are signed by two well-known personalities (Sol LeWitt and Bruno Corà) and because they markedly represent a genuine manifesto which is theoretically capable of healing the fracture that traditionally separates architecture and art history in matters of drawing intended as a form of thought.
In the first fax, dated March 22, 1995, LeWitt (at the time residing for long periods in Spoleto) tells his friend Bruno Corà (then professor of Art History in the Academy) about the delivery of the *maquette* of a work created specifically for Perugia [1]: an 'open cube' (the solid form most loved by LeWitt [2]) which, as an element of the exhibition project *City and Art*, aimed at injecting viral works into extra moenia urban areas of symbolic interest, was to be exhibited in the portico of the large public building built in those same years by Aldo Rossi and located on the western side of the Piazza Nuova in Fontivegge [3]. But LeWitt does not simply indulge in small talk and exploits the opportunity to manifest the difficulties inherent in the constructive translation of an apparently elementary work, recommending to Corà that he should not recruit students (as happened during the completion of the *Wall Drawing 396* along the entrance corridor of the former convent of San Francesco al Prato) but that he should commission expert 'masons' to carry out the work.
The second fax [4], dated March 23, 1995, contains Corà's prompt response: after thanking and reassuring LeWitt on the professionalism of the workers who would be hired by the Academy for the construction phase, he in turn urges LeWitt to reply, asking him to clarify some dimensions (''highness, thickness etc.''), but in part also indicating a hypotheses in the form of an interrogation about the 5 x 5 x 5 metres for the work and 50 x 25 x 25 centimetres for its module. A legitimate concern, but unfortunately useless because, in spite of the concreteness which distinguishes the exchange of faxes, the work remains incomplete and the *maquette*, which has been elevated to the role of a 'work', has become part of the artistic heritage of the Accademia Museum [5].
Beyond the obvious complicity between the client and the artist emerging from the cordial tone of the two faxes, the exchange between Chester and Perugia, although apparently laconic, is actually extraordinarily dense, as it opens up a broad theoretical discourse, raises three issues that implicitly assert the conceptual value of drawing.
The first question is the 'centrality of drawing', both in its formulation and construction as a work (irrespective of its artistic or architectural nature). On the other hand, for LeWitt, the role of an artist (as is the role of an architect) is not and never was to materially realise the work, but it has always been and still is to formulate the project through its drawing, controlling both its construction and its meaning via the drawing. Because in art (and in architecture) everything happens through the drawing. As mentioned in 1967 on the pages of the magazine *Artforum*, where LeWitt signs an epochal essay, entitled *Paragraphs on Conceptual Art* [LeWitt 1967], which substantially changes the attitude of artists and the general public towards drawing, elevating it from a minor to a primary means of expression, imbuing it with an importance equal to that traditionally attributed to painting and sculpture.

Articolo a invito a commento dell'immagine di Sol LeWitt e Bruno Corà, non sottoposto a revisione anonima, pubblicato con responsabilità della direzione.

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The second question is 'how drawing communicates'. Both faxes are the subject of elucidation in the appendix concerning the axonometric representation of the empty cube, which defines the shape of the work, and the concrete block, which constitutes its constructive form. Which, by manifesting the inability of any literary description to adequately establish information useful for its construction, claims the role of drawing as a privileged form of communication. Above all in the processes of remote control [Belardi 1996; Belardi 1997; Belardi 2011]: an ancient practice, which has its roots in the humanist rebirth (just think of the correspondence between Leon Battista Alberti and Matteo de' Pasti or, subsequently, between Galeazzo Alessi and Angelo Doggio), but which, from that moment on, marks the entire history of architecture, to arrive at our present day, initially with the letters drafted by Giò Ponti and Tomaso Buzzi and later with the faxes designed by Frank Gehry and Álvaro Siza.
The third question is the 'randomness of drawing'. Not surprisingly, as noted astutely by Bernice Rose, the surprises inherent in drawing, especially if geometric, fascinate LeWitt, because "drawings look different when done by different draftsmen. Those in which the instructions allow no individual decision as to placement look different because of different touch. Those in which the draftsman is left to decide on the placement of the lines within the system will look completely different each time there is a change of draftsman or location. The fact that this will happen is something that LeWitt finds interesting–and he finds these pieces more interesting than they would be if he drew them and redrew them, even with variations. It is one way of admitting chance into the work." [6] But that is not all. Because, on closer inspection, the three questions raised by the faxes written by LeWitt and Corà (but basically also the three qualities of the enunciated design i.e. centrality, communication, randomness) are not exhaustive, but are parts of a greater quality, in some ways all-encompassing: the 'conceptuality of drawing'. Indeed, for LeWitt (as for Franco Purini [Purini 1990]), the drawing is not simply the idea, but it actually 'is' the work itself [7]. Everything that comes after the drawing is 'boredom'.

Notes

[1] Sol LeWitt, *Progetto per scultura*, March 22, 1995 (Perugia, Accademia di Belle Arti "Pietro Vannucci", inv. E 534 a).

[2] "The most interesting characteristic of the cube is that it is relatively uninteresting. Compared to any other threedimensional form, the cube lacks any aggressive force, implies no motion, and is least emotive. Therefore it is the best form to use as a basic unit for any more elaborate function, the grammatical device from which the work may proceed. Because it is standard and universally recognized, no intention is required of the viewer. It is immediately understood that the cube represents the cube, a geometric figure that is uncontestably itself. The use of the cube obviates the necessity of inventing another form and reserves its use for invention." LeWitt, S. (1994). Il cubo. In Zevi 1994, p. 70. Reprinted from *Art in America* (New York), Summer 1966.

[3] Ponti, A.C. Sol LeWitt in Umbria: tracce di un percorso. In Corà, Panzera 1998, p. 36.

[4] Corà, B. *Risposta a Sol LeWitt*, March 23, 1995 (Perugia, Accademia di Belle Arti "Pietro Vannucci", inv. E 534 b).

[5] LeWitt, S. Scultura a forma di cubo. Maquette, 1995 (Perugia, Accademia di Belle Arti "Pietro Vannucci", inv. 15).

[6] Rose, B. Sol LeWitt e il disegno. In Zevi 1994, p. 299.

[7] Panzera, M. Sol LeWitt in Italy. In Corà, Panzera 1998, p. 19.

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TERRITORIES AND FRONTIERS OF REPRESENTATION

Territories and Frontiers of Drawing

Interpret the identity issues of drawing based on the relationship between past, present and future.

Towards which Representation?

Roberto de Rubertis

It was important for the first Focus of the 2017 UID Convention in Naples to be centered on the theme of the identity of drawing in terms of temporal evolution. It is the first reflection that we participants are called to face and that we "must" know how to deal with. The first question we ask ourselves, coherently with what is requested of us, is, in fact, how we stand today in the context of an evolution that has important repercussions even on teaching –if there has actually been an evolution– and how we relate to its undeniable metamorphoses or, more properly, "mutations" as Darwin would call them. Perhaps the question must be dealt with in a more specific way than has been done up to now, in particular as regards the ways in which man took his first steps on the path of communication through images; a path which also in this case (it's better to say it right away) was long and blind, like the work of Richard Dawkins' watchmaker [Dawkins 1988]. Therefore, a glance at history must be given, even if briefly, starting from very long ago; that is to say when, with the first hominids in the caves of the Paleolithic era, experiments of graphic or engraved decoration were begun and the similarity was noticed of natural or engraved marks on the walls of the caves with the visual appearances of the world: animals, actions, perhaps thoughts. But the figurative analogy, while clearly revealing how flat images can perceptively reproduce three-dimensionality, hardly shed light on what immense advantages would be derived by the first users for their

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Fig. 1. Rupestrian painting in Tassili n'Ajjer, Sahara, Algiers. Gruban photography (CCBY-SA 2.0): <https://commons.wikimedia.org/wiki/File:Algerien_5_0049.jpg> (accessed 2018, March 12).

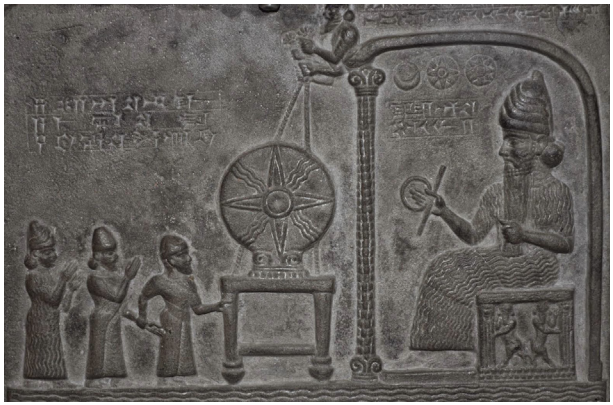


Fig. 2. Nabuaplaiddina Relief found under the pavement of the Ebabbar Sippar. London, British Museum: <http://unvasopienodiparole.blogspot.it/2016/05/i-babilonesi-periodo-cassita-il-rilievo_12.html> (accessed 2018, March 12).

own survival. The appropriation of the techniques of representation was, in fact, very slow and gradual: it did not last less than a few tens of millennia. Subsequently, opportunities began to appear which better revealed their usefulness, especially of those used essentially for signifying and ordering the various actions of daily life [Hauser 1955-1956]; and therefore those good for planning hunting forays. The ways in which these came to take shape as real, intelligent plans for creating collective strategies certainly required the prolonged length of time necessary for the slow modification of the acts and objectives of human activity. But it was not the result of conscious ameliorative intentions to determine these changes, but occasional events and fortuitous circumstances to trigger them [Gould, Vrba 2008].
This had already been demonstrated by the similarity of accidental spots or marks with the shapes of animals; and proven even more by the very origin of the physiological ability to represent things, which was favored by the skillful use of the hand, freed now from its locomotor function following the assumption of an upright posture (fig. 1).
Only much later did occasions occur in which the usefulness of also representing things that had to do with places of habitation became evident. But above all, it was the intention of making use of representations to plan the realization of habitable constructions to be late in manifesting itself. In fact, the ability to make drawings, graffiti or engravings existed much earlier than the ability to prefigure, through images, the concrete realization of what is represented. It is significant that the traces of measurements made on half-finished building materials date from before the use of these materials incorporated into functional systems: construction was first done with modules and sequences of determined physical quantities, before being based on ultimate images of their overall figurative outcomes. The marks were, in fact, initially used to shape basic, rather than anticipatory components to represent the final product [Inglese, Pizzo 2014]. In primitive design thinking, the stone comes before the column and the column before the temple.
With the progress of civilization and of culture, opportunities grew for eliciting those stimuli and those opportunities of communication which extended the practice of representation to all human activities, especially those related to the use of the image as a specific objective of aesthetic communication and information, as well as a tool for designing all sorts of artifacts. Together with the ability of "making" increasingly complex, more perfect and more useful things, the need grew for "teaching how to make them" and thus schools were born, with teachers who traced the paths and students who were able to learn their skills. As a result, along with the progress of techniques and methods, the great epics of art and graphics in all their forms ensued. Being able to re-

present became an essential tool for becoming aware of the varied and marvelous multiplicity of the world. Just as "knowing how to teach how to make it" was essential to being able to give the world an appearance, that is, to be able to communicate, in an appropriate manner, the awareness of its existence, its epochal characteristics and its identity in every respect. But also the awareness of one's own existence and of one's role in its respect: what others would then define as "the image of the world" [Schrödinger 1963].

Drawing, as well as every figurative art, especially in that part of the world which in Classical times was to become the cradle of Mediterranean culture, played an essential role in acquiring this awareness, and certainly this was their golden age, during which often sublime works were conceived and realized (figs. 2-5). All united by the desire to capture the essential features of what was gradually becoming the common human habitat, with all the meanings that culture was beginning to attribute to it. Indeed, it was culture itself that assigned human values to the world and it was culture that made the figurative qualities of space inseparable from the values that man himself attributed to it. The world was becoming the theater of human history, configuring itself as a physical, moral and spiritual construction of its life, in the way that thought itself was shaping it. Thus a new concreteness was born, which could be formalized in the figurative aspects of the world in relation to the meanings that were gradually attributed to it. Now, thanks to the possibility of capturing and fixing the morphological aspects of evolution, every change could be recognized and dated with new parameters, including figurative ones, capable of measuring and evaluating the passage of time (figs. 6-9).

It was therefore becoming possible to connect forms, and the actions necessary to configure them, not only to space but also to time, that is, once again, to the characteristics of the ongoing evolutionary phase.

An evolutionary phase in which it was making more sense to speak of quality, taste and fashion not only in the context of the ephemeral but also with reference to the most essential aspects of life and the behavioral attitudes that derive from it.

In this way, representation also channeled itself into more codified teaching paths, linked to the renewal of ways to produce and transmit images. At the same time, its infinite expressive possibilities were becoming defined and differentiated. And, while the irrepressible development

Fig. 3. The Great Sphinx. Egypt, Necropolis of Giza.

Fig. 4. Hunting scene in the marsh, 15th century a.C. Tomb of Nebamon, Valley of the King in Thebes, Egypt. London, British Museum: <https://commons.wikimedia.org/wiki/File:TombofNebamun-2.jpg> (accessed 2018, March 12).

Fig. 5. The Lion Gate, a symbolic expression of the monumental entrance of the citadel of Mycenae in the 2nd millennium B.C.

Fig. 6. The spectacular construction of the image of the world in the full expressiveness of the Palace of Knossos, 16th century B.C., here in a demonstrative reconstruction.

Fig. 7. Synthesis of expression and functionality of Greek art of the 5th century B.C. in the Erechtheum of the Acropolis of Athens.

Fig. 8. The first experiments of perspective illusionism borne witness to by the Fourth Pompeian style in the 1st century A.D.

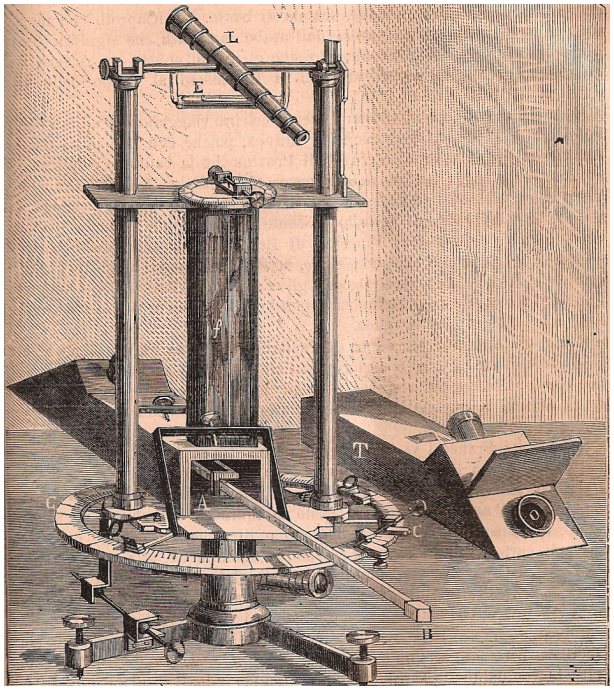
Fig. 9. The Apollo of the Belvedere, roman reproduction of a greek sculpture. Vatican City, Vatican Museum. Image by Livioandronico2013 (CC BY-SA 4.0): <https://commons.wikimedia.org/w/index.php?curid=36447892> (accessed 2018, March 12).

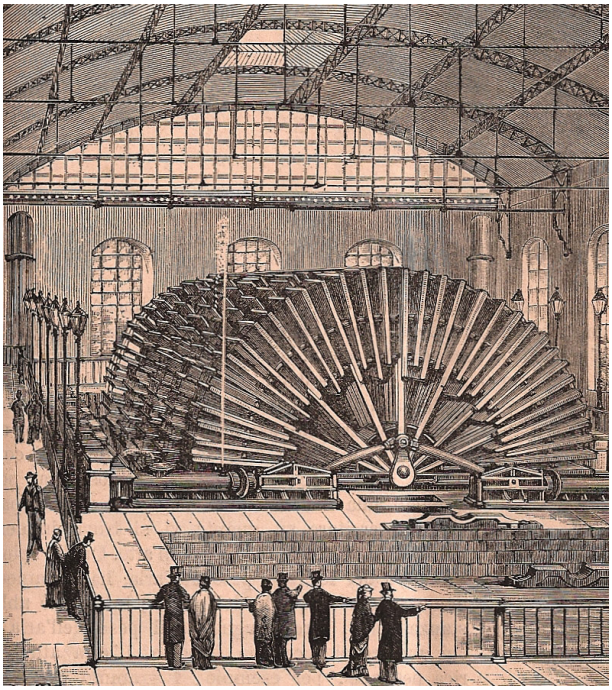
Fig. 10. Giotto, Lamentation over the dead Christ, 1503-1505. Padua, Chapel of the Scrovegni.

Fig. 11. Domenico Ghirlandaio, Expulsion of Joachim from the Temple, 1485-1490. Florence, Firenze, Church of Santa Maria Novella, Cappella Tornabuoni Chapel.

Fig. 12. Pietro Longhi, The Little Concert (The family concert), 1750-1755. Milan, Pinacoteca di Brera.

Fig. 13. Alfons Mucha, Rêverie (F. Champenois), 1897. Detail. Richard Fuxa Foundation, Foto © Richard Fuxa Foundation: <http://www.artemagazine.it/mostre/arte-moderna/item/115-milano-alfons-mucha-e-l-art-nouveau> (accessed 2018, march 12).





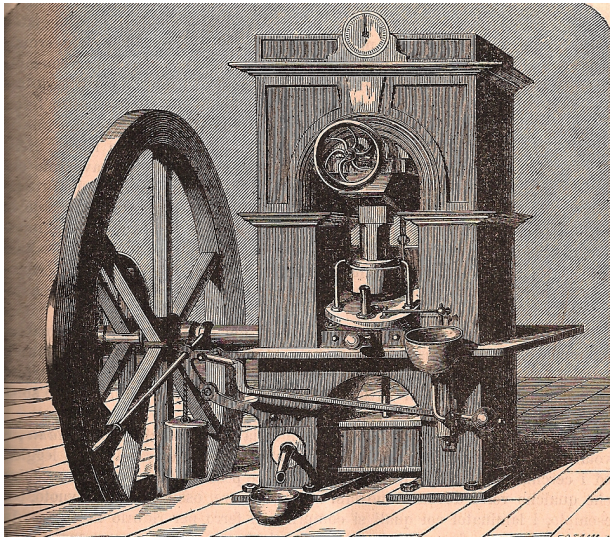


Fig. 14. Gambey's Compass. From Clerc 1885.

Fig. 15. Steering wheel. From Clerc 1885.

Fig. 16. Marly's Machine. From Clerc 1885.

of progress was oriented according to divergent tendencies, various figurative and behavioral modes became active, converging into just as many schools of thought which progressively nourished the various styles and the numerous "-isms" of culture, at first humanistic, later bourgeois and romantic, finally proletarian and, today, global. Many aspects of art and taste characterized the different attitudes, and not only outwardly, in the alternation of figurative languages, but above all for the symbolic meanings and for the social and moral contents associated with them (figs. 10-13).
Over time, and without profoundly modifying the ways of transmitting knowledge, the image explored the main paths of creation and communication of forms, avoiding the many epochal cataclysms that involved, in other re-

spects, politics and economics; in this way it overcame its "developmental crises."
In the course of half a millennium, within the respective operational reference areas, aesthetic, figurative and design research, as well as the most advanced experimentation, retained a substantial linguistic homogeneity that today, in the light of the revolutions that stir the world of communication in images, appear almost static. Even in the world of technology and science the transmission of knowledge continued to reinforce its inclination to act as a stable common language (figs. 14-17). A language that, although influenced by dated models, began to manifest the tendency for the widespread use of iconic communication that would soon begin to elevate the image to the rank of a diffused figurative language, to some extent also universal.
But perhaps in the world of images, not yet well-perceived ferments of unrest had been active for some time. If this were not so, there would have been no room for the flaring up of those sparks of innovation that ignited the minds of enlightened avant-gardes and that stimulated, during the nineteenth century, outstanding artists to push the frontiers of representation toward never-before-explored territories. On the threshold of the so-called "short century," linguistic mutations became overwhelming and, between the contestation of the old and the uncertainty of the new, they assumed the role of signs of change. The alternation of fashions became more and more rapid and frequent. Consequently, inventing, producing and transmitting images, but perhaps even more, teaching how to do so, became a crucial issue involved in producing culture.
I again ask myself if this sign of change is also a sign of evolution for civilization and perhaps even for the image. I therefore think of the main objective of this note, in which I would like to distinguish the sense of evolution as "progress," in the sense of an advancement towards the best, which would require a qualitative judgment, from the sense of evolution in the true Darwinian meaning of the term, that is, the simple replacement of previous models with other more recent ones. Assuming that this change, while being implicit (and necessary) for the effectiveness of the substitution, does not necessarily imply the conscious intentionality of the goal. And at this point, I would ask myself more precisely: is there a substantial "improvement," over time, of the methods of representation and the ways of teaching it, or is it just a matter of technical innovations, not concerning the meaning and

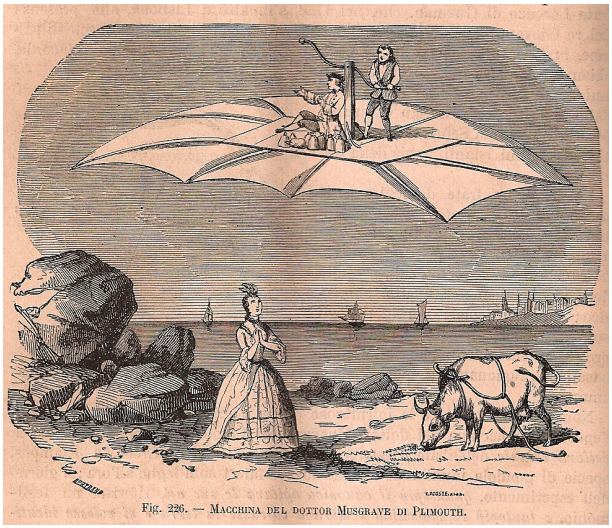


Fig. 17. In the illustration of "La macchina del dott. Musgrave" ("Dr. Musgrave's Machine") there are depicted, without any ironic intention, epochal attitudes. From Clerc 1885.

the profound objectives of the procedure? To put it simply, as an example, and with the benefit of hindsight, can we consider perspective an evolution in a progressive sense, therefore intentionally improving representation, or only an evolution in the Darwinian sense, and therefore a simple, circumstantially advantageous instrumental mutation? We know today that, in light of the reflections offered to us by Cubism, the question is open.
Not only, but we are consolidating the certainty that we can never talk about "better" or "worse" ways of expressing ourselves with images, but perhaps only of which circumstances have caused the success or the decline of particular representative models, possibly never determined by deliberate and conscious intentions, but only by the accidental mutations of trends.
It will not, in any case, be the problem of the finalization, or not, of the evolution of the image to affect the profound meanings of evolutionism, but the question is certainly important. For those involved in representation, it is not irrelevant to know whether the changes that characterize it today are part of the flow of events that testify to a great epochal, decisive and "wanted" event, or whether they are to be counted among the occasional

Fig. 18. The Bilderatlas Mnemosyne shows with which attitude, at the end of the 20th century, we began to re-evaluate how the images of the past had been able to capture and transmit the immense complexity of events, testimonies and reflections, which characterized the times past.

and temporary mutations that can be fully evaluated only in retrospect.
In other words, the question is not terminological, but substantial: it is perhaps the first time that one wonders about the evolution of the image, calling into question its epochal mutations and then subjecting even the evolution of its models of reference to criticism, in trying to make sense of what we do. For this reason, we give great attention to the comparison of our behavior with that of those who preceded us, even in representing the world: Aby Warburg with his *Bilderatlas Mnemosyne* has offered a famous example (fig. 18). Today we study the ways in which, in the past, we have represented life, we investigate how we studied the environment and by which interests or curiosities we were driven. In doing so, we focus not only on how these were different from today's, but above all, on how different we were then, as we recorded them and therefore, what the observations we made were. Were we more merciless, more permissive, more superficial? In the dark ages were we too severe when we condemned the past, or were we too lenient when, with ingenious nineteenth-century triumphalism, we welcomed the new and exalted the "magnificent and progressive destiny" of the future? Evidence of these various judgments that remains fixed by images, mirror of reality, is the most authentic testimony and the most precious measure of the time past. We well know the allure and complacency aroused by the exploration, sometimes fascinating, sometimes critical or ironic, of the differences between current models of life and those, for example, of the 1920s. To compare them stimulates transversal reflections and moral judgments whose transience and fallacy can lead to our questioning the validity and universality of what we consider today the most essential values of life, that is to say, what it is right or wrong to do, both socially and morally.
The surprising mutation (figs. 19, 20) sustained today by inhabited and lived-in places, certainly the most radical in the history of humanity, requires us to not defer the question confronting us: that is, how we must orient ourselves in guiding the changes in modes of communication. Naturally in the context of the figurative tools within our competence, if it is possible to do so.
In fact, while the great megacities present a picture of a living environment in which almost nothing of what belongs to normal language is fully recognizable, even representation opens abysses of unpredictability. Are other horizons really opening for other objectives or is there the fear that the new *chances* for understanding the world are just new myths?
I refer mainly to the disponibility of images to be manipulated with the new information systems, with virtual experiences, with augmented reality and with the simulations of every order and degree that storm the world of communications and which promise, or perhaps only claim to offer, more fruitful perspectives for knowing and doing.
We ask ourselves if the race toward the new forms and the new contents of representation has been a useful

race or just a senseless flight toward an alternative world that in many respects was proving to be a failure. We had thought of perhaps taking a journey alongside a friendly avatar to be sent ahead to probe the unknown results of technical, social, economic and behavioral experiments of a renewal that, basically, was not sought and, rather, whose consequences were feared.

Fig. 19. Congested space in New York City: <http://wallpaperswide.com/aerial_view_of_new_york_city-wallpapers.html> (accessed 2018, march 12).

Fig. 20. Vision of a megalopolis: <https://pixabay.com/it/edifici-grattacielocielo-nuvole-2581875/> (accessed 2018, march 12).

Now we go back to asking ourselves if the new instruments of representation and knowledge of that hopefully better world will be effective for understanding it, at first, but then for living there, using and perhaps enhancing and loving it. So not just to exorcise it, reducing the distance that separates us from it, but to grasp its mutability and to give it a current meaning, in the footsteps of what

Fig. 21. The Coliseum: Augmented Reality (ARmedia 3D Tracker): https://www.archeomatica.it/ict-beni-culturali/armedia-3d-tracker-nuova-applicazione-per-ibeni-culturali-in-realta-aumentata (accessed 2018, march 12).

Fig. 22. BIM application obtained using Autodesk Revit: <https://www.autodesk.com/solutions/bim/hub/what-is-bim> (accessed 2018, march 12).

Aby Warburg did in the last century. In this sense, the current increase in studies on the representation of the environment and the landscape is a good sign. New and updated operational tools are being made available to us for establishing a conscious and intense connection with the globality of the contemporary world and with the continuity we wish to maintain with the past (figs. 21, 22).
Here we come back to our initial question: is this a generically explorative phase or are we participating in a conscious epochal evolution from which we can expect the hoped-for better future? Some predictions, or perhaps only some hypotheses, attribute representation with a more secure capacity of control and completeness with respect to the falsifiability of the word. It seems that the image can offer greater guarantees of correspondence to the truth, but perhaps it itself could be thwarted by the pervasion of the illusion, deception, error and falsity, or at least of the superficiality, neither more nor less, of the way it has been up to now.
The question is of the utmost importance: in our hands, as teachers, do we perhaps hold an instrument of truth?
We know that representation is a solid and lasting thing, but we ignore the extent to which iconic language can productively substitute alphanumeric language. We are certainly flattered to be protagonists of this essential mutation of the role of the image and we can be confident that it is an important evolution, but this time, not only in the Darwinian sense, that is, not only as a succession of mutations that "ex post," accidentally, prove to be advantageous, but in the sense of intentional and conscious refinement of communication, oriented to transmit truer truths. And therefore we would like to think that the image, as a renewed and more effective means of communicating "just" thought, will become a more authentic language, capable of transmitting, perhaps more than words, messages of truth.
Will we witness, or rather, actually participate in its "guided" genetic mutation? It would be a decisive step on the path of evolution and could perhaps trigger that spark of lucid intuition, a conscious promoter of perfection, whose existence is so intensely opposed by the most intransigent evolutionism.
Darwin held that just one of these sparks would undermine the entire castle of his theory, and I, myself, (*si parva licet*…) must agree. It would be a beautiful adventure of thought to take part in a process of "purification" of the image, transformed from a messenger of lies to a repository of truth.
May we all –members of the UID, its guardians– share in this hope.

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Drawings and Scale Models Used in Building the Spanish Royal Sites

Pilar Chías, Tomás Abad

Abstract

In 1545 Emperor Charles V created the Board of Works and Forests to define and control all the building projects promoted by the Crown. As a result, the administration of the royal estates was updated and modernised due to its pyramidal structure. The building works were supervised by architects or draftsmen, who were responsible for the project's definition and construction respectively. The latter should also define the building contracts and build the models to be used by craftsmen. Following completion of the construction work, the administration of the royal site was entrusted to a governor or alcaide, so that the building process and management were distinctly separated. King Philip II transformed the previous practices into a strict regulatory framework affecting every craftwork, and defining in detail each piece of work in the building contracts. They included frequent references to moulds and models, and even sketches. Accordingly, the main targets and original contributions of our researtch are: 1/ to link the graphic documents to the written building contracts in order to make evident their complementary role, what will permit to know under which circumstances they were produced; 2/ to extend the research subject to every craftwork in the palace's construction, and not just to the stonework; 3/ to diffuse such an interesting set of documents that is essential to the history of construction in the 16th century, and particularly to the history of the royal works. For this purpose we publish for the first time some of these documents and drawings.

Palabras clave: Drawings, Models, Royal Sites, History of Construction, 16th Century.

Introduction

The construction of the royal works in Spain was regulated since 1545, when Emperor Charles created the Junta de Obras y Bosques (Board of Works and Forests). "The reason why it was created was to conserve the royal palaces, houses, sites and forests, to look after them and increase their number, and to repair their masonry." [Garma y Durán 1571, IV, 513]. The Junta remained active until the 18th century, when the powers and activities of the House of Bourbon [1] were being curtailed by a series of reforms and the decline of the institutions founded by the Habsburg dynasty [Díaz González 2006] [2].

The Junta had a strict pyramidal structure, being the supreme legal authority in regard of all royal sites, and having power to act in cases of game and fish poaching, but also in all business dealings or legal suits arising in them.

As far as building was concerned, since the Board's mission was to protect the monarch's interests, its functions consisted in defining and supervising all work carried out in palaces and estates belonging to the crown. And to assist it in its labours, some relevant rules were drawn up governing the contracting, supervision, building, valuation and settlement of projects.

On the other hand, some powerful aristocratic families as the Mendoza, Medinaceli or Alba built remarkable buildings and gardens in Renaissance style. But the most ambitious ensemble of constructions was undertaken by the

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Fig. 1. Scale model of the wooden framed structure of one of the 'chapiteles' (spires) over the towers in the Monastery. Patrimonio Nacional.

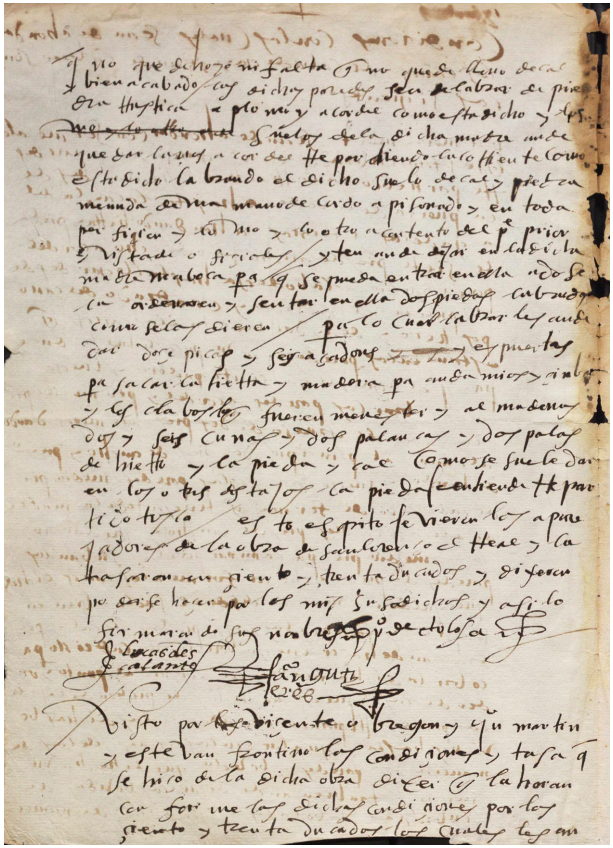
Crown under the control of the Junta, with great expense to the royal treasury [Checa 1992, pp. 34, 35]. Among the famous Spanish architects that worked in the construction of the royal sites, Covarrubias, Machuca, Egas, Luis and Gaspar de Vega, and Villalpando must be stressed.
Despite the importance of the investments made by the Crown, until now no systematic study has been made on the procedures and regulations that governed the management and control of the royal works. They are all still available in the numerous documents preserved in the Spanish archives [3].
To date, these aspects have only been studied in relation to very particular details of a building project [Bustamante 1994, pp. 36-52, pp. 128, 129] such as roofing, fluvial flood contention, the quarries in a region, and so forth; there has been no comprehensive treatment of the crafts involved or of the building process as a whole. With only few exceptions, neither has any research been conducted to date into the important role of sketches, full-scale drawings and models in royal building projects, nor to how they related to building processes [Chías, Abad 2017; Chías, Abad 2018].

From drawings to construction

Building projects on the royal sites answered needs as varied as the refurbishment of an old building, the extension of an existing one, or the construction of a completely new palace.
The involvement of the monarchs in the building processes varied considerably, but none of them equaled King Philip II's attempts to control both the evolution of the works and the results. This trait of his character was highlighted by the Flemish gentlemen Jehan Lhermite [Lhermite, 1602 (1890-1896), p. 245]: "The natural inclination of the Monarch for every subject related with construction, and particularly with good layouts and finishes of his houses"; and also by the chronicler Luis Cabrera de Córdoba [Cabrera de Córdoba 1619 (1876-1877), p. 786]: "He was inclined naturally to build, enjoying the transit of things from their absence to their existence".
Once the general layout was drawn up by the royal draftsmen or architects according to the king's purposes, the

contracting process commenced following rigorous procedures that were only altered in case of singular or fine works.
Labour was paid at a daily rate or was contracted as piecework [4]. The pieces were assigned according to terms and conditions that had been published beforehand.
Although assignment was sometimes made directly, generally because of the degree of specialisation called for it, it was the custom for a public announcement to be made throughout the county –and sometiimes beyond– which permitted pieceworkers in different crafts to apply for one assignment or another.
Before adjudicating the pieces, the king himself issued a word of warning to the piece workers, recommending that "they should give careful consideration and thought to the terms and conditions and the work to be done [...] and that no piece shall be assigned without having first complied with this requirement, and that once that is done and the samples of stonemasonry or carpentry have been prepared for the pieceworkers to follow, the assignment of pieces among expert and well-known workers should be decided, and contracting them at an agreed price, the pieces should be thus assigned, not by means of the usual auction, because if good workmen are given the jobs at fair prices, the work will be done well and in line with the samples and layout" [5]. As the text shows, the King mentioned clearly the use of moulds, samples and sketches.
The pieceworkers had first to prove their solvency and then to deposit an execution surety before being finally adjudicated the work.
Work on each piece was done in accordance with a detailed description of the tasks to be performed. This included the materials to be used and their characteristics, the dimensions of each of the elements to be built, how to set them in place, and the cost and period of execution.
Details were also given of the auxiliary means to be used, such as shoring, cranes and tools –often at the king's expense– as well as of the materials and bonding agents to be employed, and of where to find them on the site, which was usually a point accessible to carts.
In line with its specification, each piece was given a detailed evaluation taking into account not only the materials but also the qualifications of expert workers and hired

Fig. 2. Conditions for sinking and fitting the cellar duct, with signatures. Real Biblioteca del Monasterio del Escorial, Doc. I-64.



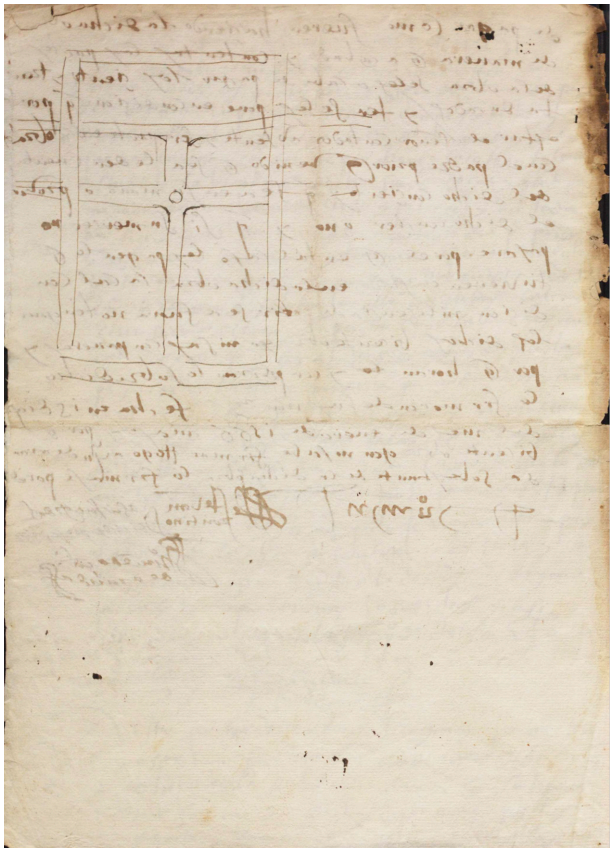


Fig. 3. Conditions for sinking and fitting the cellar duct, with signatures. Sketch. Real Biblioteca del Monasterio del Escorial, Doc. I-64.

hands, and the time employed. If the work was attractive, the hands "made their bids" at the corresponding auction like tenderers.

Documents related to the works in the Royal Monastery of El Escorial

The works in the Monastery of El Escorial are particularly interesting. Despite its importance and the volume of work that was carried out, it was built in record time thanks to a well structured hierarchical organisation supported by successive *Instrucciones* (*Instructions*) –issued by King Philip II between 1562 y 1572– and by several *Órdenes* (*Orders*) dealing with some particular crafts.

An outstanding set of original handwritten documents relating to the works in the Monastery is preserved. It contains essential information about all project phases between 1563 y 1586. Building contracts and private correspondence between the king and the Hieronymite prior show the stage-by-stage planning and development of the work.

The documents also reveal the hierarchical nature of the project. While the architects were basically the draftsmen and site supervisors, it was the king and trusted courtiers – the Architecture Council or Consejo de arquitectura– and the monastery's resident Congregation of Hieronymite Friars who discussed and decided issues related to design after viewing the corresponding models (fig. 1).

Below those were the master builders (stonemasons, masons and carpenters). These took charge of setting out, moulding and templates, as well as supervising the work on the different pieces. They were also responsible for taking measurements, surveying the works, and valuing them. Work on each specific section of the building and particular tasks was done in accordance with a detailed description of the tasks to be performed. This included the materials to be used and their characteristics, the dimensions of each of the elements to be built, how to set them in place, and the cost and period of execution. A case in point at the El Escorial site was the manuscript, dated 1564, setting out the "Conditions for sinking and fitting the cellar duct" [6].

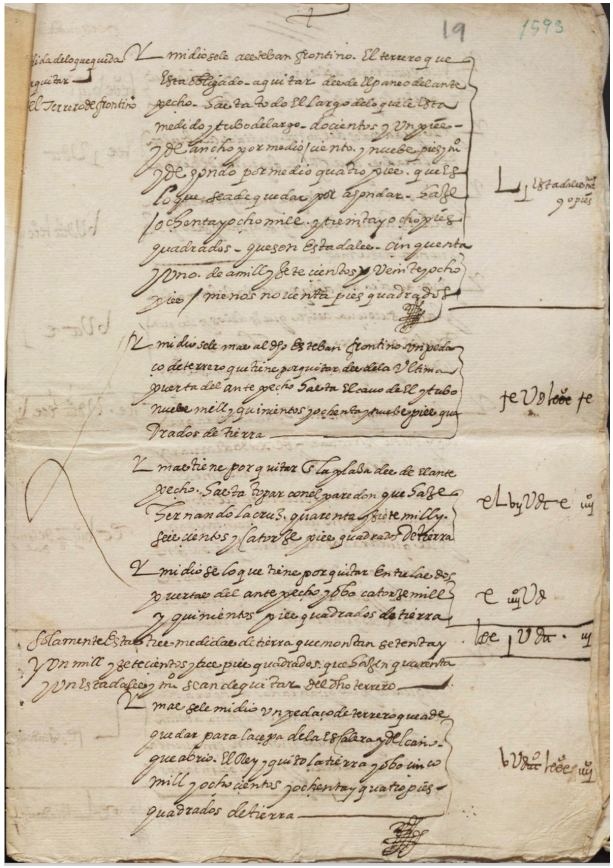
As an essential piece of work of the plumbing system, it

was put out to tender once the foundations were laid and the load-bearing walls arose from the cellar level. The contract specified that the work had to be done as follows: "using a string, make a straight trench in the earth and stone, seven feet in width, along the centre of the cellar to the door on the right and the square of the final duct […] then use a plumb-line to build the walls with stone and lime mortar at least two feet thick, giving the start of the duct a width of two feet and a depth of one and a half feet […] then build the vaults of brick to cover said main drain […] also, remove shoring from the vaults, which shall be sail vaults, and plaster them […] and use a string to ensure the floors of the main drain are flat, covering the floor with stone and lime mortar […] to this end they have to be given twelve picks and six hoes, as well as baskets to remove the earth and wood for scaffolding and shoring; nails as required, two sledgehammers, six wooden shims, two levers and two iron shovels, and the stone and lime mortar as is usual in such pieces […] and this document was read by the master-builders of the San Lorenzo el Real site, who valued it at one hundred and thirty ducats and said it could be done by the aforementioned, and signed it with their names". This was followed by the signatures of all the pieceworkers and the king's master-builders, the former undertaking to work "in compliance of the terms and conditions" and at the agreed price (fig. 2).

The written specifications were often accompanied by sketches and drawings; they even referred expressly to the use on site of templates and models by means of the formula "as per the corresponding plan and full-scale drawings" (fig. 3).

Below the architects were the master builders (stonemasons, masons and carpenters). These took charge of setting out, moulding and templates, as well as supervising the work on the different pieces. They were also responsible for taking measurements, surveying the works, and valuing them. To that end, they decided how the measurements were to be made. One example of this relates to the monastery's main sacristy, that is located at the main cloister or Claustro de los Evangelistas. The works began in 1568, one year after Juan Bautista de Toledo's decease, but yet according to his traces: "This wall must be measured from the corners of the columns inwards, without including the

Fig. 4. Measurements taken during earthwork in the Lonja. Real Biblioteca del Monasterio del Escorial, Doc. XII-24.

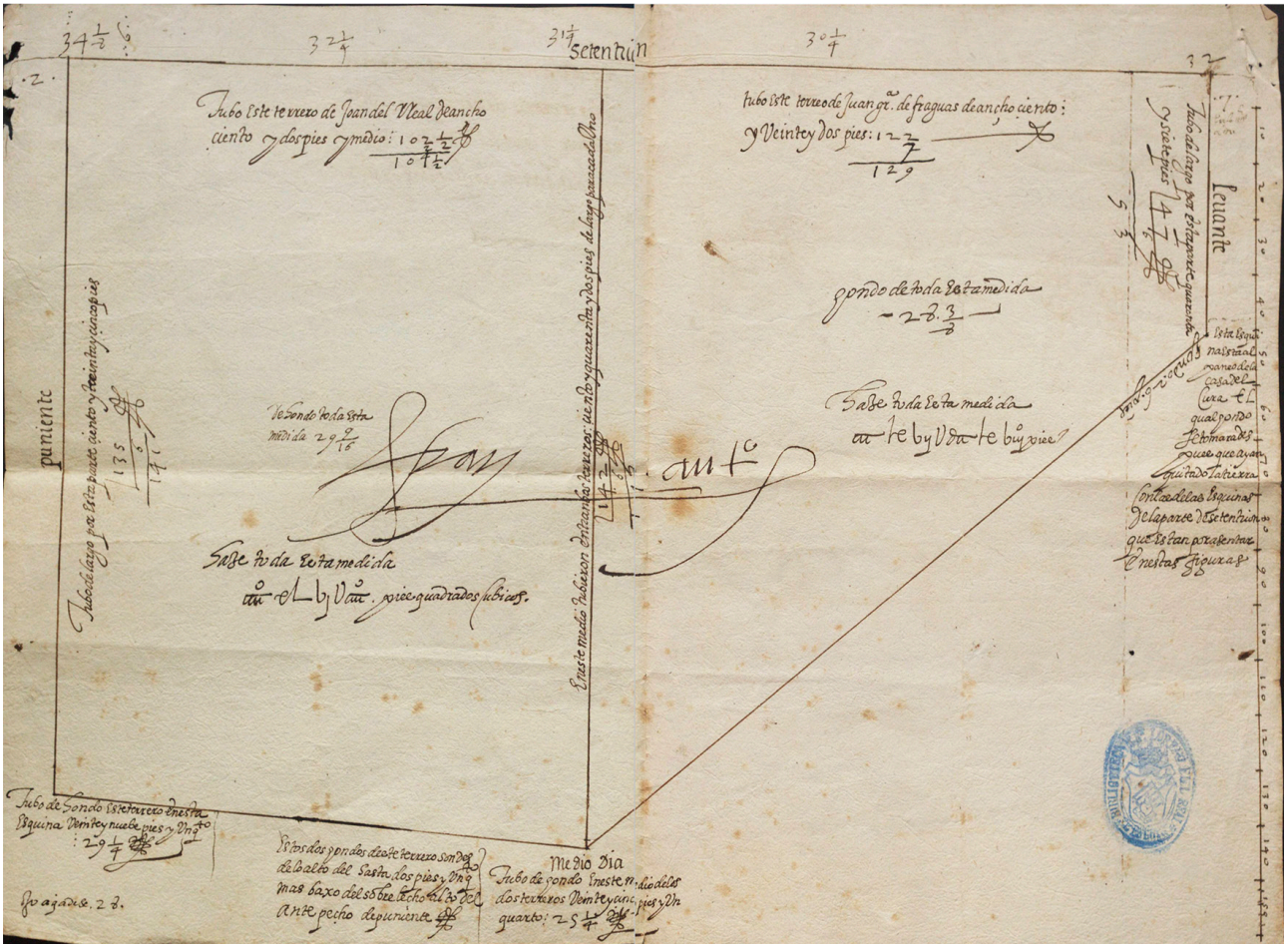


protuding parts of base, capital or cornice mouldings, to the top of the cornice, and from there to whatever there is of a certain thickness" [7].
This procedure was repeated several times during the development of the works, but always before signing the settlement. And if necessary, drawings were added in order to facilitate the identification of each measure (figs. 4, 5).

Drawings, sketches, full-scale drawings and moulds

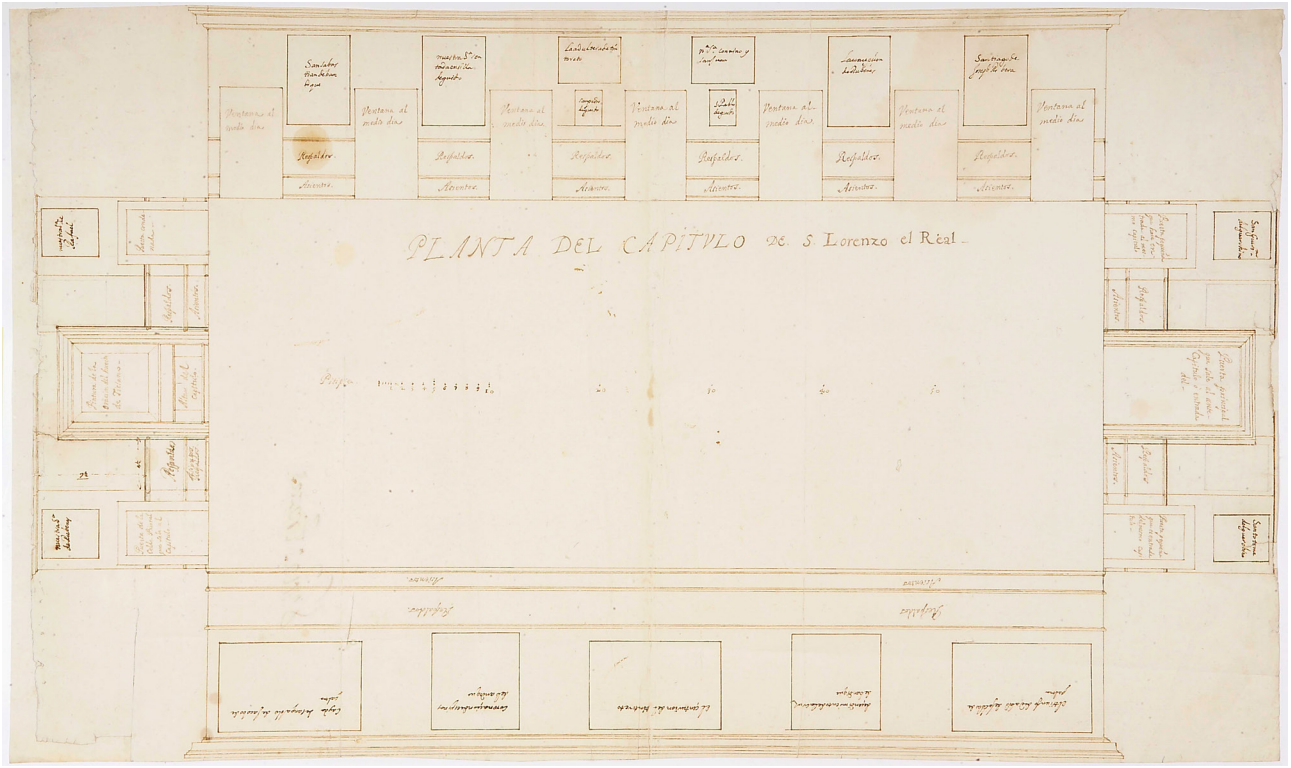
An interesting set of original drawings survives, still within the corresponding contract and complementing to perfection the written details.
Some of these drawings were intended for the foreman, while other were the result of architects' design solutions or just working drawings for consultation by workman on site. To the first category belong "carefully drawn, large-scale plans and elevations for presentational purposes", being the second group just schematic plans done rapidly to see what something might look like. The third category corresponds to the 'master plan', which is on the basis of the assembly of all parts into more complex structures. [Kostof 1984, p. 15].
The series of Estampas representing the Monastery by Herrera and Perret –engraved between 1583 and 1598– can be assigned to the first category, together with the set of drawings in the Library of the Palacio Real in Madrid (fig. 6).
Sketches produced to define significant architectural details within the building contracts belong to the second category. They represent the formal and metric aspects of the architectural elements and their pieces, that were essential to make the moulds and other necessary tools.
In contrast, the monteas or full-scale drawings were done of floors or walls in the latter stages of the building process. Showing with great precision the pieces making up each element and their distribution, they enabled tighter control of the work, thereby avoiding errors due to changes in scale [Calvo 2016] and proving at the same time the usefulness of geometry and drawing procedures. The term *montea* is used elsewhere in the documents to mean elevation or side. The joint use of full-scale drawings and sketches is very common in the terms and conditions given to the bricklayers for the chapter house vault: "the chapels have to be done in brick and plaster as per a plan and full-scale drawing given" by the master-builder Pedro de Tolosa; in addition, "the centre-points of the vault and the windows must coincide with the marks on the floor, and said builder will make the bracing and shoring at his own cost but from material given to him as stated" [8]. It is worth pointing out that the use of sketches was not limited to stonemasonry but extended across all the crafts. A letter sent by the secretary to the king in August 1565 mentions the drawing for the model of grilles for the lesser cloisters: "Juan Bautista [de Toledo] made the sketch for the remaining grilles of these two cloisters, and after discussion with the fathers and others, he agreed how they all had to be and set to making a wooden model. He will come here to make it in iron and, once finished, will send it to Pero González de Escalante, for them to be made in Vizcaya". The king added in a note: for this, make haste on the iron model" [9].
As for the use of full-scale drawings, only some remain of the monastery's southern or '*Platerías*' basement walls and of the Prior's Tower staircase [López Mozo 2008]. We have dated the former to late November 1564 [Chías, Abad 2017] on the strength of architect Juan Bautista de Toledo's Memoria: "I proceeded to revise all the measurements and have them marked with chisels and nails, with numbers and red ochre above them, because the rainwater of the last few days had washed them away" [10] (fig. 7). The second group of full-scale drawings is of the Prior's truncated staircase, the construction of which was completed in 1574.
Unfortunately, no moulds or original models sur- vive due to their fragile materials –brass and wood–, on-site wear and tear, and the succession of fires that afflicted the palaces from the 16th century onwards. Nonetheless, the complementary function of sketches, moulds and models was a constant at both the design and the construction phases. In so far as the models helped understand solutions adopted for particular parts or the whole, they were essential to decision-making during the building process. The sketches were always done beforehand; taken as a whole, they provide a glimpse of how the work on site was done. A royal

Fig. 5. Sketch defining the measurements of the earthwork in the Lonja. Real Biblioteca del Monasterio del Escorial, Doc. XII-24.



writ of 2 February 1562 already mentioned "the sketch and model being made" [Llaguno y Amírola 1829, II, pp. 227, 228]. In April, the secretary, Hoyo, informed the king that "in response to what your Majesty instructed, Juan Bautista [de Toledo] told me that he would finish shading either by yesterday afternoon or this morning, and would then set about raising the funds required for work on the model to commence, and I offered to make available to him whatever timber was necessary" [11].
It was common to refer to the model in order to de- termine building solutions. That was the case with the main stairwell and the ledges of the stairs down to the orchard, it being specified that "all these stones for the ledges have to be stapled together and arranged as can be seen in the model made for the purpose; the stapling has to be done with the same stones to avoid any ugly effect, as can be seen in the model, making sure the ties are always neat and tidy as stated for everything else […] at his Majesty's expense, for all this work a mould for each difference, a bevel and trusses will be made available, and should more be needed, they will be made at his expense too, and the wood and tin plate to make them provided too" [12].
The documents also show how partial models by different hands were used persistently throughout the building

Fig. 6. Ground plan of the Chapter in San Lorenzo el Real. Real Biblioteca, Palacio Real de Madrid, Sign. IX_M_242_1 (33).

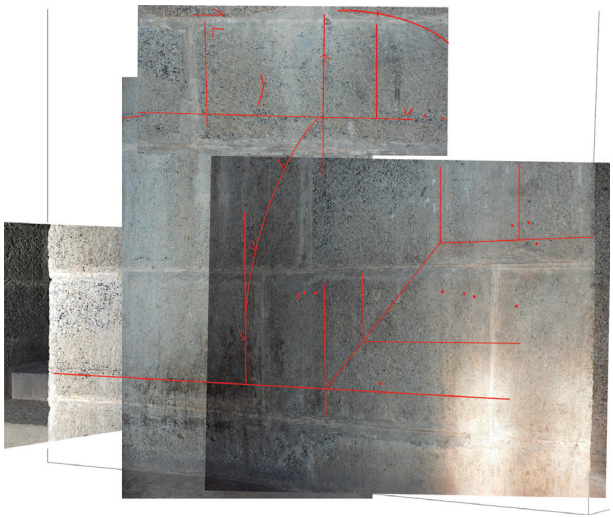


project to help decide on solutions. Thus, a letter sent by Juan Bautista de Toledo to Hoyo reads: "I herewith send to Jerónimo Gili, my former disciple, who is in charge of the model of the corners, which is done in two ways: one as if the corridors had to be vaulted, and the other as if done in wood" [13].
Apart from the model of the whole complex, the next in importance was the model of the church. The skilled carpenter Martín de Alciaga started work on it in 1573 using earlier versions based on sketches Diego de Alcántara -who was one of the stone-masons master builders. It took him two years to carve [Lasso de la Vega 1945].
Still extant are those corresponding to the lesser cloisters, the main cloister, the wall of the niches, the main staircase –for which architect Juan Bautista Castello Bergamasco also made a model–, the church, the palace, the roofs and steeples, the college and the "offices and everything else that fits inside the picture".
On a smaller scale, 'little models' were also made, such as those for the door to the kitchens, for the plaster strips around the windows, for window ledges, for the cell locks, and even for the grilles.

Conclusions

The procedure followed for contracting, executing and settling royal building projects in the 16th century was extraordinarily modern and well-defined. It continued into the 19th century in crown building contracts and still persists as the essence of Spanish legislation concerning state contracts.
The use of different types of drawings, models and moulds was common practice at every stage of the project.
The sequential use of sketches, models and full-scale drawings, in close combination with written documents, is evidence of how the work was executed and, as has been demonstrated, was the norm for all crafts involved in the project.
The way these complemented each other is clear from Cabrera de Córdoba's [Cabrera de Córdoba 1619 (1876-1877), VI, p. XI] remarks on the El Escorial Monastery project in which, he claims, everything was done "on paper, whether the whole, sections or parts, and then on a wooden model of the whole project because by taking them together, a better overview could be obtained, and so that whatever modification were required, whether in overall form or particular part, could be made, always with a view to improvement, since it was difficult to be right first time when planning and installing so many different things".

Fig. 7. P. Chías and T. Abad, 2017: Photomontage of the full-scale drawings in the basement of Platerías in the Monastery.



Notes

[1] Particularly the palaces of La Granja de San Ildefonso and Riofrío, both located in the province of Segovia.

[2] The Habsburg dinasty started with the reign of King Philip I in 1504, and ended in 1700 when King Charles II died without descent. Followed King Philip V, who was the first king of the Bourbon dinasty.

[3] These are mainly the Archive and Library in the Palacio Real in Madrid, The Library of the Real Monasterio de San Lorenzo del Escorial, the Archivo General de Simancas in Valladolid, and the Instituto Valencia de Don Juan, also in Madrid.

[4] Destajo: work assigned to be done and paid according to a fixed price.

[5] Instituto de Valencia de Don Juan, Envío 61(1), ff. 1r-2v.

[6] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Doc. I-64.

[7] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Doc. III-5.

[8] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Doc. II-94.

[9] Instituto de Valencia de Don Juan, Envío 61(1), ff. 327-330.

[10] Instituto de Valencia de Don Juan, Envío 61(1), ff. 31-32.

[11] Instituto de Valencia de Don Juan, Envío 61(1), ff. 327-330.

[12] Real Biblioteca del Monasterio de San Lorenzo del Escorial, Docs. I-90 y II-177.

[13] Archivo General de Simancas, Obras y Bosques, Escorial, leg. 3.

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The Architectural Perspective of the *Apotheosis of Venice* by Veronese: Geometrical Analysis and Digital Restitution

Silvia Masserano

Abstract

The research examines a large di sotto in su *canvas entitled* Apotheosis of Venice, *realized between 1579 and 1582 by Paolo Veronese for the ceiling of the Hall of the Great Council of the Ducal Palace in Venice. The* telero, *surveyed with the tools of digital photogrammetry, was compared with a preliminary model of smaller dimensions. From the geometric comparison of the two works, in reference to the location of the main vanishing point and its relation to the real enclosure, it was found that the author planned the perspective apparatus of the painting by assigning a precise position to the observer. Applying the operations of perspective restitution to the architectural apparatus of the canvas and reconstructing the plans and the heights of the painted scene, we have come to a stereometric modeling that has allowed a greater understanding of the work. Further considerations which emerged from the analysis of the preparatory drawing have also made it possible to hypothesize the use of a direct system of perspective construction by the Caliari workshop.*

Keywords: Paolo Veronese, quadratura, survey, perspective, perspective restitution.

Introduction

The object of the study of thhis essay is a large canvas (904 x 580 cm) dated 1582 [1] and entitled *The Apotheosis of Venice*, created by Paolo Caliari (known as the Veronese) for the ceiling of the Hall of the Great Council of the of the Venetian Ducal Palace (fig. 1).
The work depicts the personification of Venice with the appearance of a queen seated on her throne between two crenellated towers, symbols of solidity and impregnability. The sovereign is crowned by a winged Victory while Fame plays a golden trumpet to proclaim her glories. At her side there are gods of Olympus to symbolize her role as peacemaker of the peoples, guarantor of freedom and bearer of happiness and abundance. Behind her, an imposing scene, conceived as a dynamic and luminous theatrical scenography, from whose twisted columns rise two bronze statues: Mercury as the emblem of eloquence, and Hercules, of strength. The architectural scene is animated by the presence of a large group of nobles, foreign prelates and bystanders who, looking out from a balustrade, celebrate the good governance of the city, while some soldiers keep watch over the crowd.
Of this famous painting there has been preserved a preparatory drawing (fig. 2) of considerably smaller dimensions (ca. 52.5 x 35 cm) but very similar to the final work. The similarity between the sketch and the work has allowed us to undertake a comparative analysis aimed at identifying similarities and differences between the two figurative works. Furthermore, the two formats, notably different from the dimensional point of view, have also al-

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Fig. 1. Paolo Caliari, Apotheosis of Venice (1582), Hall of the Great Council in the Ducal Palace, Venice (photo by Silvia Masserano).

lowed us to investigate perceptual problems related to the criteria for using the painting, and above all to hypothesize the methods used by the painter for its realization.

The survey of the painted canvas

The photographic survey of *The Apotheosis of Venice*, aimed at acquiring a study image of the work were conducted with the aid of a reflex camera equipped with a telephoto lens, the back of which was placed parallel to the floor so as to realize partial ortho-photographs of the ceiling. The shots were taken at regular distances, using the parallel axis technique, in order to cover the entire pictorial field by means of a general grid of frames, from which to extract the photographs that allowed a reconstruction of the image of the canvas. A further survey was made for the acquisition of details, so as to increase the level of detail of significant elements, especially as a function of the subsequent perspective restitution. These images were then mounted with the technique of digital photo-mosaic, which allowed the interpolation of the same through the partial overlapping of the edges, using the Photoscan software for semi-automatic photomodeling. The image processing phase envisaged the maintaining of the frame made up of the wooden frieze, even though it could actually be masked with the options provided by the software (fig. 3). It was decided, in fact, to eliminate what is present outside the edges of the canvas with a photo-editing software for greater quality control: this procedure also provided an intervention on the color range in order to make the shades correspond even more to the current state of conservation of the painting.

Comparative analysis

Once the digital image of the *telero* was obtained, the analysis of the painting was begun. As with any large-format composition, Caliari had to make numerous study drawings for this work [2] in order to define the organization of the chiaroscuro model, the work that preceded the painting of the canvas and defined the master's guidelines to the assistants. To date, the only study model concerning the composition of this work, was made between February 1578 [3] and 1582: it is a drawing done with pen and dark brown ink, treated chromatically with watercolor bistro and white lead, divided into squares with black chalk, on reddish paper, fixed on a backing and folded horizontally (fig. 2).
This drawing is the result of the phase of the work in which various ideas were grouped on a perspective frame in order to be able to make changes [4], so it cannot be identified as the chiaroscuro model. In fact, the organization of some characters and objects depicted in this sketch does not correspond exactly to those painted on the canvas. Rather, the function of this work was to establish the

Fig. 2. Apotheosis of Venice, preparatory drawing (1578-1582). In Marini, Aikema 2014, p. 195.

organization of the main subjects without specifying their characteristics, that were instead specified in a subsequent model, together with the arrangement of the figures of secondary importance and other elements [5].
It is also noted that in the model, the dimensions of Venice and of the divinities that surround her are very small compared to the dimensions that were attributed to them in the finished work. Moreover, since the left-hand niche is empty and the right-hand niche houses a different statue from the solution used in the painting, it is assumed that the assistants assigned to perform certain portions of the work were given the opportunity to introduce some elements according to their own creative flair. Also for what regards the scenographic apparatus, there are some differences between the model and the painting.
The dentils that decorate the central part of the cornice of the entablature in the sketch are fewer than those present in the canvas: this depends on the fact that in the finished work the segment of cornice placed at the center is wider. Then, in the final version, the depth of the two protruding portions of the architrave supported by the twisted columns is also increased.
In the preparatory drawing, the twisted columns are not subdivided into drums and are not fluted, and the crenellated towers, presumably the result of a belated idea, in the *telero* are wider.
But the greatest discrepancy concerns precisely the change in perspective shown by the comparison between the preparatory drawing and the finished work, a modification that allowed the painter to accentuate the inclination of the scene in order to make the whole imposing architectural structure seem to loom upward. Without doubt, the entity of the prospective rectification between this preparatory drawing and the execution of the work required the preparation of the lost chiaroscuro model.
From a perspective point of view, the sketch and the work are organized according to different methods of foreshortening.
To quantify the extent of this variation –and to understand its possible reasons– a geometric comparison was made between the sketch and the painting concerning the position of the main vanishing point and its relation to the real environment.
In the drawing, if we consider the geometry referring to the contour of the trabeated cornice, a sequence of right angles can be noted. By extending the angular verification to all presumed straight profiles and belonging to surfaces similar to horizontal planes, the same result is noted. This finding implies the parallelism of the planes that can be associated with horizontal surfaces and consequently the presence, in the preparatory drawing, of a perspective device with a horizontal picture plain.
In the painting a similar comparison has revealed, except for negligible imperfections, the same results and therefore the same perspective apparatus. However, as already mentioned, the position of the elements that make up the internal reference of each system is different.

Fig. 3. Ortho-photomosaic and ortho-rectified image of the painting (elab. Silvia Masserano).

Prolonging in the sketch the perspective lines comparable to the orthogonal to the painting, that is, the corners of the triumphal arch perpendicular to the horizontal reference plane, the position of the main vanishing point was determined, whose projection on the floor of the environment destined to receive the work did not indicate either a specific location connected to particular positions, nor a position linked to the peculiar conformation of the hall.
In the *telero*, the extension of the edges similar to the orthogonal to the painting has determined, in the common convergence point, the position of the main vanishing point at a distance of 16.50 m from the intersection of the canvas axes and the virtual extension of the longer axis. This location corresponds exactly to the center of the room (fig. 4).
Considering the findings that emerged from the above-mentioned verifications, it can be seen that from the execution of the sketch to that of the painting, Veronese perfected the position of the main vanishing point to arrange the point of view in the center of the room, exactly in front of the Doge's throne.

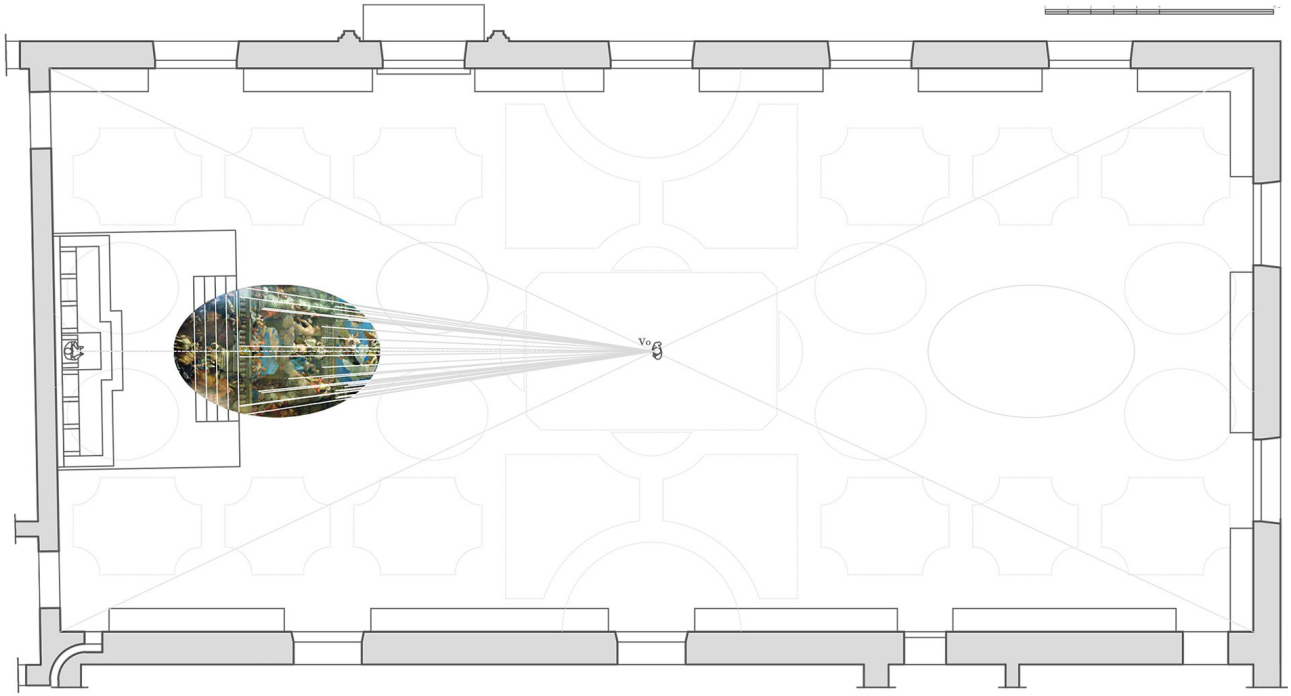

Fig. 4. Position of the main principal point of the painted perspective of the telero (elab. Silvia Masserano).

Perspective restitution

In the perspective device of *The Apotheosis of Venice*, the horizontal reference plane can coincide or be parallel to the picture. Accepting the first hypothesis, the main distance corresponds to the spatial interval between the observer's eye and the pictorial surface of the canvas. Having learned this parameter through a simple metrical comparison, the internal reference of the system was completed and the prospective restitution operations could be started, a process which, for reasons of symmetry, was applied to only half of the painting in which the architecture was most visible.
Before embarking on the executive protocol, some geometrical relationships were recognized, necessary for identifying the perspective axis of the tortile column, and for reporting some measurements attributable to the proportions dictated by the composite order. The connections in question concerned, beyond the center of the *sommoscapo* and the circumference drawn on the extrados of the abacus, the corners of the plinth which, related to the aforesaid axis through trajectories inclined by 45°, allowed the specification of the heights connected to the overall development of the column. Having established a reasonably plausible dimension for the *sommoscapo*, it was possible to find the height and the *imoscapo* of the tortile column. With this last measure it was possible to compare the extension of the column axis, and to observe that in the restitution its proportion did not respect the theoretical precepts prescribed by the composite order, a totally anomalous condition for an architect-painter. The irregularity could depend only on the measure attributed to the main distance of the reference system, which was lower than the one established by Veronese. From this observation it was deduced that the painter did not define this parameter by means of a survey, but he quantified it by relying on other criteria.

In *La pratica della prospettiva* [6], a compendium published in Venice in the decade preceding the realization of this canvas, Daniele Barbaro suggests placing the eye of the observer at a suitable distance in relation to the size of the painting, leading the aforementioned spatial range to a geometric construction demonstrated in application to five different examples. In particular, by applying to the work in question the instructions dictated by the last of the five cases, the position of the canvas assumed a distance from the point of view equal to twice its real length.
By making this correction, the restitution of the size of the *sommoscapo*, of the *imoscapo* and of the height of the tortile column, was actually proportioned according to the ratios established by the composite order. Therefore, maintaining the same reference, the prospective restitution of the architectural scenery was undertaken.
The restitution of the painted architecture began precisely from the twisted column which was completed with a base and a composite capital. The restitution then continued with the reconstruction of the entablature, perfected in the profile of its cornice by means of a homothetic magnification. Then the dentils and floral decorations were inserted, and after having modeled the projection from the wall parameter of the architrave, the pilaster was added next to the tortile column. With a few altimetric references transferred through the pilaster on the axis of the column, the side niche and a column under the central arch were also outlined.
Therefore, always, by means of the homothetic magnification, the depth of the level of the central focal point was proportioned and, consequently, the relative intrados surface. The base of the tortile column was supported by the cymatium of a pedestal corresponding to the one represented in the painting, while that of the column under the arch was recomposed together with its pedestal according to the proportions of the composite order. The different levels of the two bases justified the presence of an incline that was geometrized by means of some steps, visible between the balustrades drawn in the preparatory sketch. As far as the parapet is concerned, since no precise reference was available, it was possible to create a space between the balustrade and the base of the architectural structure, formulating a hypothesis of alignment for the axes and the twisted column. At the foot of the balustrade, the underlying cornice was added, sketching in, as far as possible, the recess framing the Lion of St. Mark.
The restitution could not go further, but it was decided to complete the part below, respecting the alignment with the point of view, but attributing arbitrary depths to it. To the counter-façade, the same configuration of the main façade was instead conferred. The façade of the architectural structure was also composed from the plan and the section reconstructed.
In addition to the aforementioned clue provided by the sketch, concerning the presence under the central arch of a staircase, by an accurate observation of the *telero*, another detail was discovered that allowed extending the composition of the painted architecture. The detail in question was found at the end of the entablature superimposed on the right Solomonic column, where a self-bearing shadow was depicted, whose conformation similar to that projected by the epistyle superimposed on the tortile column, indicated the existence, beyond the margin of the *telero*, of a further twisted column placed to support it. In light of these considerations, two giant columns were added to the two side niches (fig. 5).
The reconstruction thus restored an imposing structure, elevated by a short staircase, with a vaulted passage and decorated with statues and bas-reliefs like a triumphal arch. The hypothesis that it is a celebratory construction is supported by the presence of capitals modeled according to the principles of the composite order, an order also called triumphal, because it is used precisely in triumphal arches. The main honorary meaning of this particular architectural structure thus adheres perfectly to the theme of the painting.

Digital model construction and projective verification

With the metrical information deduced from the perspective restitution, the three-dimensional *maquette* of the triumphal arch was modeled in a digital environment (fig. 6). Then, using the parameters taken from the perspective analysis, a perspective view of the model was generated to verify the results achieved.
To make the comparison even more effective, the presence of human figures was superimposed on the perspective simulation, which evidenced only one incongruity concerning the pose of one of the two servants, taken up in the act of climbing up the left-hand tortile column and, consequently, of the man with a turban portrayed behind him. Compared to the perspective reconstruction the two subjects are moved away from the shaft of the tortile column. The defect is attributed to an imprecise correspondence of symmetry between the two halves constituting the painted architecture (fig. 7).

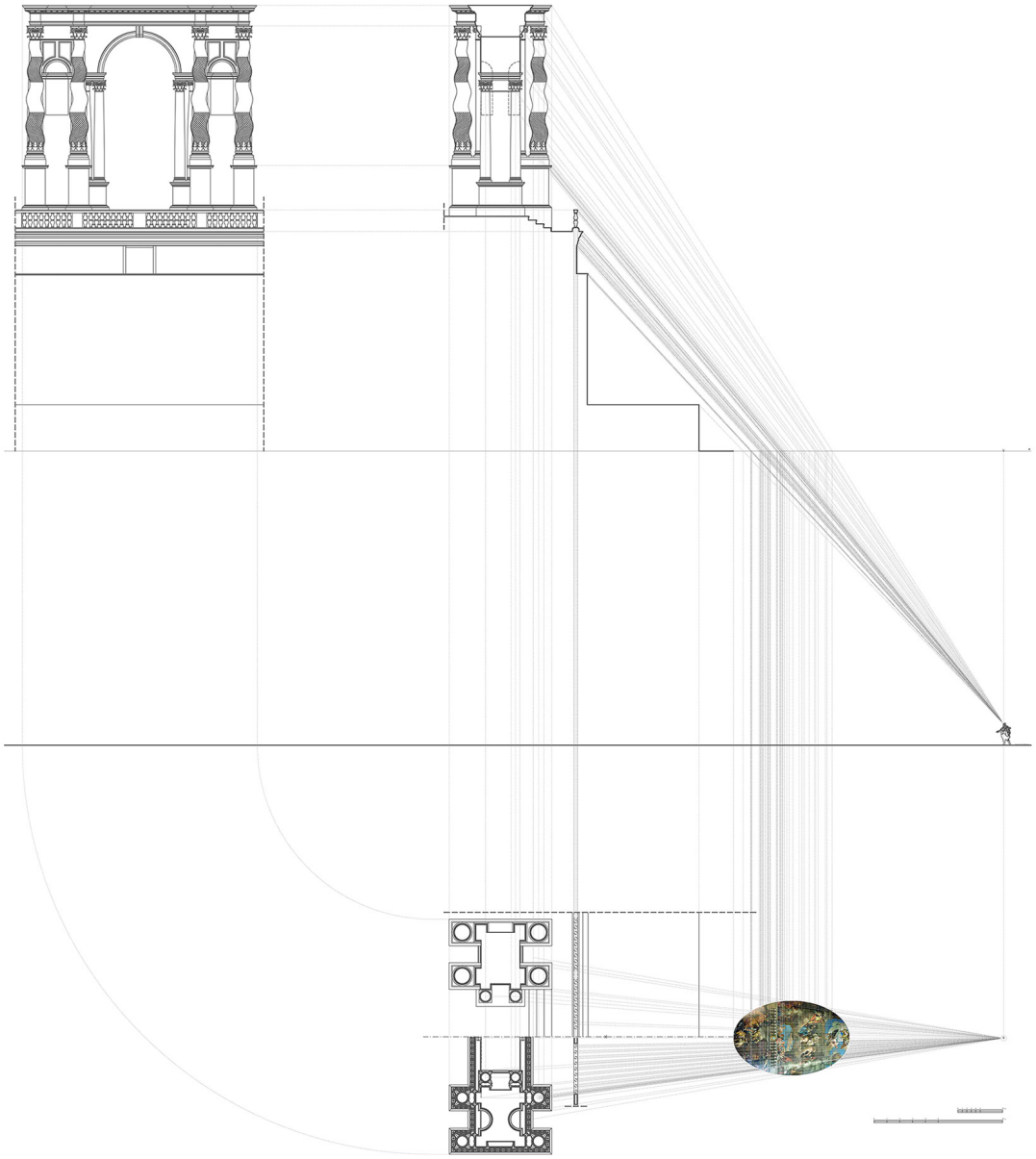

Fig. 5. Mongian projections restituted by the perspective restitution of the painted architecture (elab. Silvia Masserano).

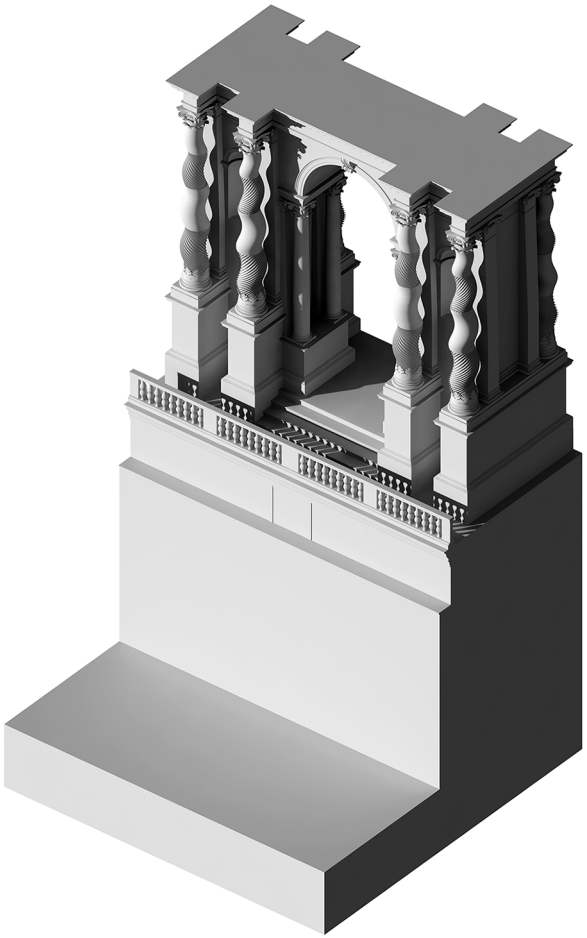

Fig. 6. Digital maquette of the triumphal arch (elab. Silvia Masserano).

Fig. 7. Overlapping of figures on the perspective of the digital model (elab. Silvia Masserano).

Conclusions

Veronese acquired his particular inclination for the representation of foreshortening from the painting of mannerists known between Mantua and Parma, and among these, the work of Giulio Romano certainly represented an important stimulus for Caliari. He knew the work of Giulio Romano, and certainly also the ways in which he used to realize his famous *di sotto in su* perspective illusions, systems that Paolo already applied with the inspiration of a specialist at the young age of 23. In this respect, the cartographer Cristoforo Sorte also played an important role, as he had learned directly from Romano how to realize *di sotto in su* effects using an ingenious artifice. The expedient involved the following: the three-dimensional model of the architecture that was to be depicted was built and placed

on a mirror duly divided into squares by a grid of threads (fig. 8); observing the image reflected in the mirror with an eyepiece placed at a distance equivalent to the predetermined principal distance, one could easily visualize the perspective from underneath the object, which was easily copied onto a sheet provided with a grid congruent to the grid of threads arranged above the mirror [7].
The acquaintanceship and long-standing familiarity that linked the cartographer Sorte to Caliari makes it probable that Veronese also knew of this method: in fact, for the realization of the ceiling views, it is possible that he used a mirror as a tool for perspective. The propensity for this hypothesis is based on some observations that emerged during previous prospective investigations.
During the analysis carried out on some ceiling canvases by Veronese [8], prospective systems emerged in which the heights of the architectural apparatuses converged towards a vanishing point, while the extensions of the horizontal edges describing the depths of the same structures reached, on the opposite side, another vanishing point. Perspectives of this kind, which can be assimilated to devices with an inclined picture plane, can be easily reproduced using the mirror method, tilting the *maquette* towards the observer.
It has also been noted that in the settings of Veronese *sotto in su* paintings, there are often: spiral columns raised by plinths, with twisted shafts and subdivided into four drums and ending with a composite capital; arches equipped with entablatures from the intrados decorated with mixed decorative elements, complete with cornices supported by corbels alternating with floral elements and variously shaped banisters. The repeated presence of these elements in the ceiling perspectives leads to the hypothesis that in the Caliari workshop three-dimensional reproductions of these elements –reduced in scale– were used to facilitate sketching, in the preliminary drawings, of more complex compositional structures in the background. This assumption can be upheld by recalling the profession practiced by the head of the Caliari family, a stone mason specialized in the reproduction of architectural elements, who certainly must have produced a large number of these objects in demonstration of his skill. It is therefore likely that this kind of models could be present in workshop belonging to Paolo, who could use them in various formations and, by placing them on a mirror, quickly choose, the perspectives most suitable for the pictorial themes of the numerous orders entrusted to him.

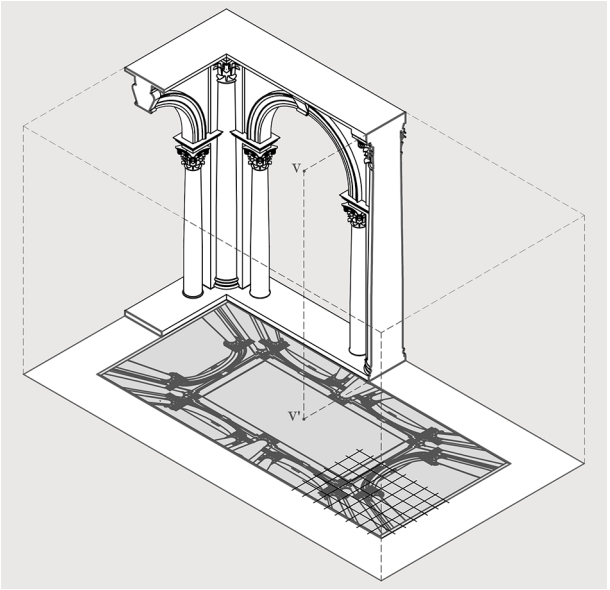

Fig. 8. Reconstruction of the perspecive tool created by Cristoforo Sorte (elab. Silvia Masserano).

From the sketch of the *Apotheosis* to the finished work, the perspective of the architectural apparatus changes. This sketch must be followed by the model with the final, definitive perspective, but if the perspective of the scene is changed, the presence of the squaring on an "outdated" system is not understood: the grid was used to transfer the preparatory drawing from one support to another, because the cells of the grid provided precise points of reference that facilitated the reproduction of the subject, in its form and in its proportions. This grid was traced onto the finished drawing, but in some parts of the *Apotheosis* sketch the aforesaid grid is veiled, if not actually covered, by watercolor, rather than by highlights applied with white lead.
This can be explained by hypothesizing that the grid was drawn when the watercolor was not completely dry, or that the chromatic treatment partly absorbed the grid markings drawn with chalk. In the latter case, the application of the color must be attributed to a phase chronologically subsequent to that related to the drawing of the grid. But if it is assumed that the

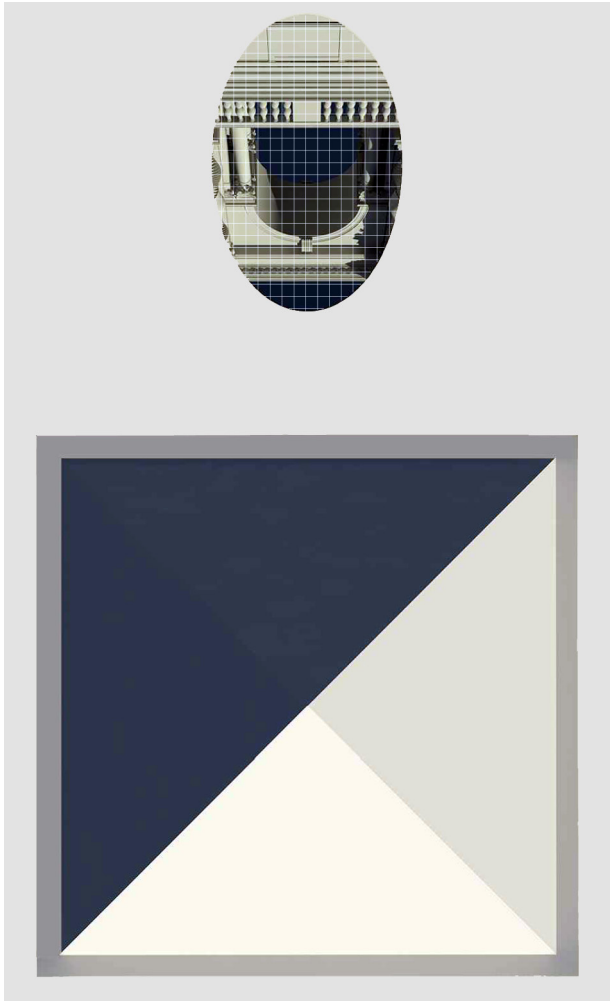

Fig. 9. Simulation of the perspective view obtained by reflection of the partial model in the mirror (elab. Silvia Masserano).

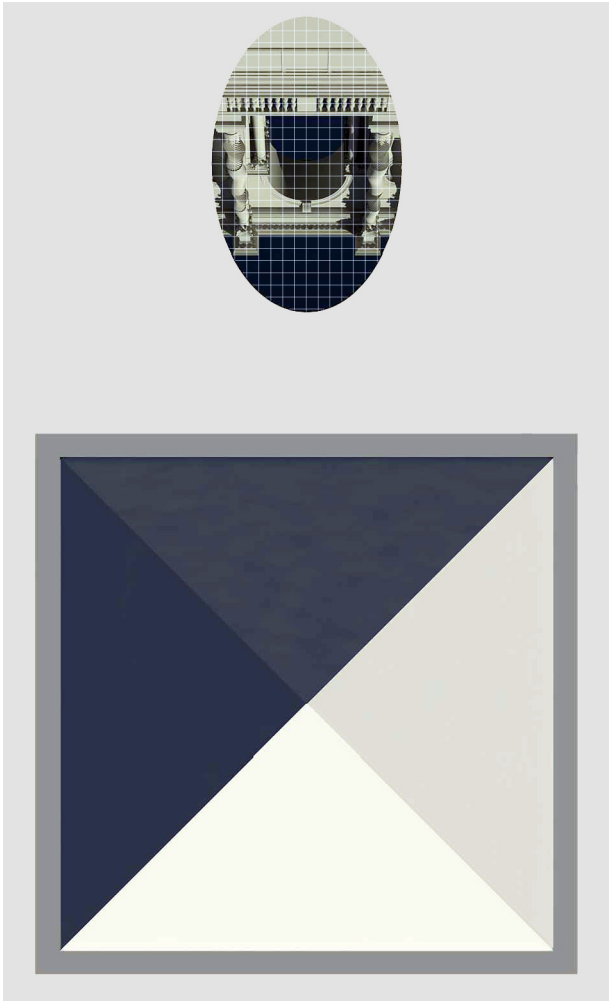

Fig. 10. Simulation of the perspective view obtained by reflecting the model in the mirror (elab. Silvia Masserano).

grid was traced even before the architectural backdrop, then the grid could have a dual function, mainly as a support in the construction of the architectural structure and secondly, duly reinforced, as a device for copying the drawing on the next support.

In the preparatory drawing for the *Apotheosis*, the apparent contour of each of the two twisted columns, drawn in pen with brown ink, is developed with the sole aid of a projected ray drawn in charcoal and without the support of other guidelines. In *di sotto in su* perspective, the geo-

metric construction of a complex subject cannot make use of such a limited reference, therefore the supposition that they were copied from real life or that they were reproduced by tracing seems more well-grounded.
If a mirror is used, the shading of the model in the reflected image is specular, that is, reversed from left to right, in respect to the real object. To correct this defect, it is sufficient to trace the drawing on the back of the drawing sheet, an operation that makes it possible to reproduce only the outline of any object represented. This circumstance would explain the absence of a complete outline of perspective construction in the preparatory sketch.
Although the above observations may lead to the hypothesis that in Caliari's workshop it was customary to use a reticulated mirror for preparing *sotto in su* views, we should remember that the tool for perspective described by Sorte envisaged the same lenght both for the height of the model and the main distance (fig. 8), a circumstance instead ignored by the result of the perspective restitution on the work: the height of the model produced by the perspective restitution is, in fact, greater than the extension assigned by the painter to the pointer, a dimension that according to the indications of the cartographer had to be equal to the main distance.
An obvious difference in the rendering of details between the upper part of the architectural scene (including the triumphal arch, the balustrade and the niche with the Lion of St. Mark) and the lower one (including only a rising supported by a simple platform), the hypothesis that the model used for reflection in the mirror included two distinct elements, the triumphal arch and the underlying support platform. To the above is added the singular coincidence recorded in the heights of the most accurate portion of the model, which corresponds exactly to the extension of the main distance.
The two findings suggest that the painter followed the instructions of Sorte in the construction of the architectural model, but that he had to raise it with a base improvised at a later time.
A digital simulation clarified the reasons for this.
After having removed from the model restituted by perspective restitution the portion relative to the raised platform, and having modeled a pointer as tall as the length of the main distance, the model was placed next to an elliptical mirror proportioned according to the size of the *telero*. Having placed the eyepiece in a position corresponding to the station point identified by

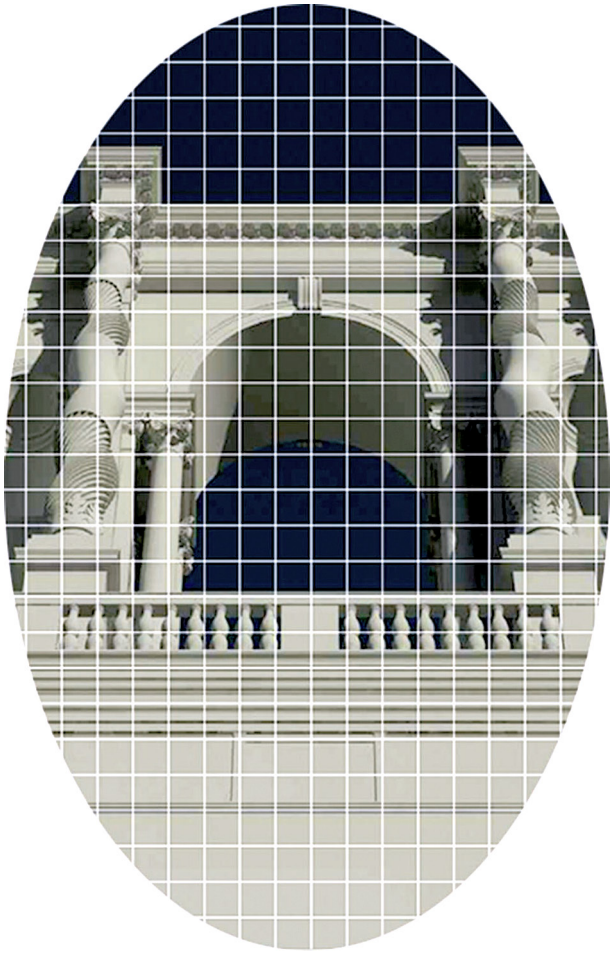

Fig. 11. Reflection of perspective in the mirror (elab. Silvia Masserano).

the perspective analysis, the image that could be captured from its apex on the reflecting surface did not show the presence of the two twisted columns (fig. 9), a circumstance that prevented recognition of a scenic background appropriate to the theme of the canvas. So in order to make the model recognizable in the mirror image as well, the painter had to raise and lower the

maquette, a condition that required the introduction of a terraced platform (fig. 10) to the "stage setting", that was then animated with the different poses of soldiers and plebeians.
As regards the dimensioning of the grid of threads stretched over the mirror, in the digital processing the above-mentioned measurement was evaluated in the reflected image as equal to one eighth of the distance between the edges of the two protruding segments of the cornice, since in the sketch eight cells are included in the same interval of space. Finally, a further reflection imposed on the view captured on the mirror from the eyepiece has made it possible to correct the direction of the light source, giving the digital view the appearance given by the tracing of the previous drawing (fig. 11), that is, the appearance of the final sketch. The analogies found by comparing the result of the simulation to the sketch of the *Apotheosis*, can rightly prove the assumption regarding the use of this instrument in the configuration of the *telero* of Palazzo Ducale, and allow us to presume that by means of this expedient the author was able to easily change the perspective scheme of the painted ceiling simply by changing the position of the pointer.

Notes

[1] In 1582 the *telero* was in place on the ceiling of the Hall of the Great Council, as confirmed by Raffaello Borghini in *Il Riposo*: Borghini 1584, p. 562.

[2] Cfr. Bettagno 1988, p. 75.

[3] 1578 is the year in which Veronese was entrusted with the task of carrying out the work. Cfr. Ridolfi 1837, pp. 45-47.

[4] Rearick, W.R. Paolo Veronese disegnatore. In Bettagno 1988, p. 43.

[5] A reference, for example, to one of the four figures intent on climbing the shaft of the Solomonic columns.

[6] Barbaro 1568, pp. 19-23.

[7] Cfr. Sorte 1580, p. 15.

[8] The ceiling paintings examined are those realized for the Venetian churches of San Sebastiano and Santa Maria dell'Umiltà.

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Territories and Frontiers of Research

Interpret the many variable dimensions of the identity of research in the field of architectural and environmental survey and representation using examplesof case studies critically open to integration with other theoretical/operational fields of knowledge.

The Scientific Dimensions of the Digital Model

Mario Centofanti

The representative model

All of our activities of *Surveying, Documenting, Analyzing, Interpreting, Planning, Communicating* necessarily converge or rotate around the 'representation model', whether it be of 'restitution' (from a survey), of 'reconstruction' (of a non-existing reality and/or design aims) or of prediction (restoration, project).
Survey is the full expression of disciplinary specificity and autonomy, as regards methods and techniques, but still an integral part of the more complex process of "historical-critical analysis." An analysis that must lead to an integral and integrated knowledge of the architectural specifics, of the clustered buildings, or of the urban reality subject to observation, and to the expression of a "value assessment" in relation to aesthetic and historical instances [Brandi 1977]. The result of a survey has never been just a "restitutive model." In a preliminary phase (pre-gained knowledge) and then in parallel to the survey, the researcher deals with the collection of archival documents, historical iconography, photographs, etc., building up the philological-critical *corpus*; he also plans mapping campaigns with decay analysis, the documentation of constructive values (techniques and materials); he executes critical elaborations, synchronic and diachronic historical sections, reconstruction of non-existing configurations, proportion analysis, metrology.

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The researcher thus builds a "complex representative model" of the reality he observes. All of which in order to pursue the fundamental and undeniable aim of his research: to reach a greater level of knowledge than at the beginning.
But the representative model thus generated also constitutes the fundamental support for the construction of a Restoration project (as a cultural act and a creative act) given a fundamental specularity between survey and project [Carbonara 1977]. And this also applies to the project for new buildings, where it implies the knowledge and, therefore, the survey of the context.

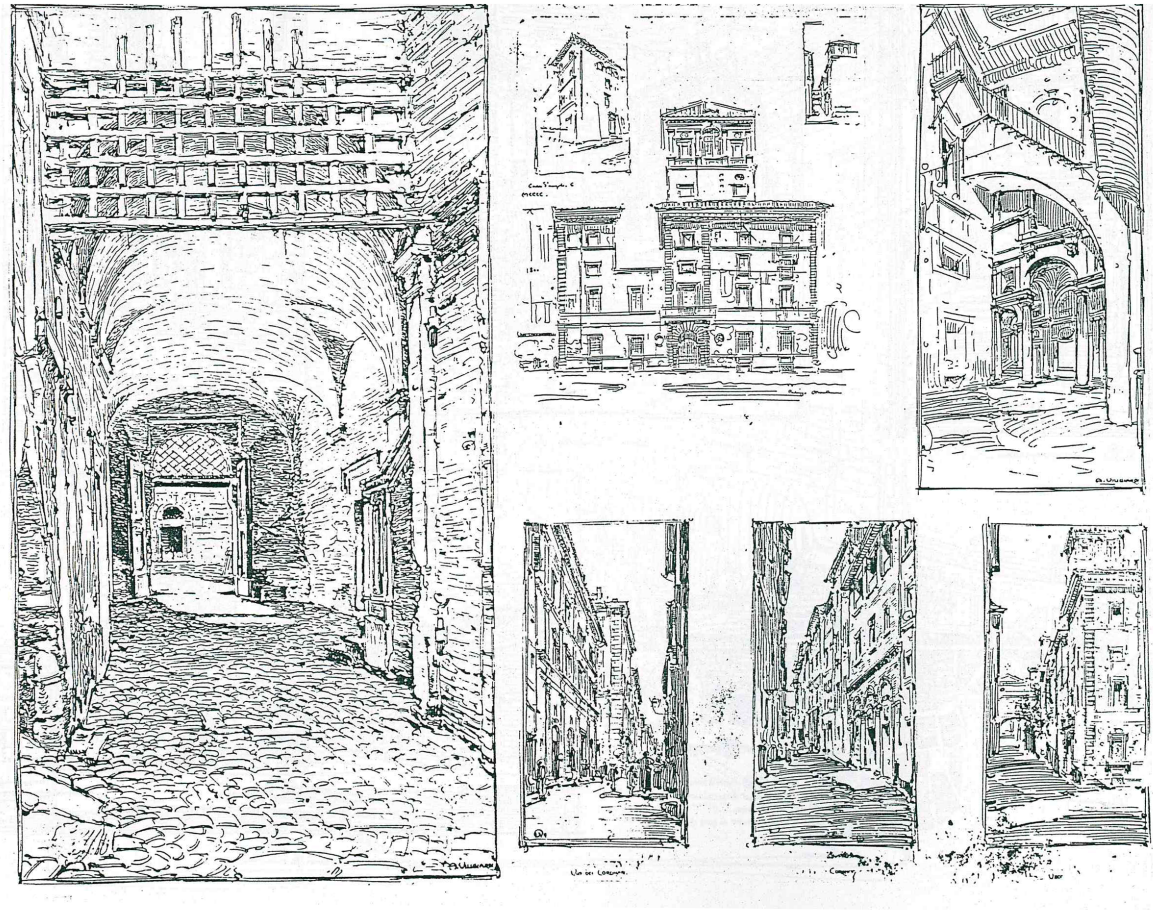
The nature of the model

Modern epistemology defines modeling as a cognitive and communication strategy, as well as a creative one [centofanti 2016; Centofanti 2013; Centofanti 2012; Centofanti 10a; Centofanti, Brusaporci 2012; Centofanti et al. 2011]. In reality representation, the model faces the prerogative of "similarity". With reference to semiological studies [Eco 2015] there is a difference between iconic and non-iconic models (mathematical or diagram). But the concepts of structure, function and form also have to be considered. In this sense a model can be considered: "homologous" (structure correspondence), "analogous" (structure and function correspondence), "isomorphous" (form correspondence). More in general, the model can be defined as "text form," itself made up of multiple forms of text and image-text.

The traditional representative representative model

We propose a rather old historical reference, but which illuminates (in terms of conceptual opposition) some qualities of the contemporary digital representative model.
It is a rather well-known example, relative to a significant experience of Gustavo Giovannoni (1873-1947) at the *International Exposition in Rome*, in 1911, specifically at the *Roman Topography Exhibition at Castel Sant'Angelo* [Centofanti, Cifani, Del Bufalo 1985]. In room 1, *Building studies*, at numbers 11 and 12, Giovannoni presented, in two exhibition panels, the "*Rilievi e studi per la sistemazione di Via dei Coronari e adiacenze*." To comprehend the meaning of this operation, it is important to recall that Giovannoni had published an article in *Nuova Antologia* in 1908 with the emblematic title "*Per le minacciate demolizioni nel centro di Roma*" [Giovannoni 1908], later reprised more systematically, again in *Nuova Antologia* in 1913 [Giovannoni 1913].
The critical discourse of 1908 was targeted to the proposals contained in the Urban Development Plan by Sanjust di Teulada, that Giovannoni considered to be destructive for the peculiar characteristics of the historic urban fabric, with particular reference to Via dei Coronari.
His idea was that of juxtaposing the "gutting" of the city with what he defined as "*diradamento*", that is, the "thinning out" of the urban fabric: «in some extremely narrow points of the old streets, and if hygienic reasons should suggest bringing air and light, we could thin out the houses here and there, by removing some factories or unimportant blocks and placing small squares or small gardens in their place; by opening in certain places, without letting oneself be seduced by the geometric regularity of a wide street, without changing the environment with new constructions» [Giovannoni 1908, p. 319].
Let us briefly examine the exhibition he set up. The first panel (fig. 1) contains four drawings by Arturo Viligiardi [1] and includes a series of perspective views of urban spaces and buildings' interiors with entrance halls and courtyards: Perspective views of the entrance of Palazzo del Drago, of the façade of Palazzo Montanara, of Via dei Coronari and Via Vecchiarelli and of Palazzo Vecchiarelli's courtyard.
The second panel (fig. 2) contains part of Via dei Coronari's site plan, signed by Giovannoni, with the proposal for Via dei Coronari's restoration and four perspective view drawings by Viligiardi, related to the plan, of Via dei Coronari, Piazza San Salvatore in Lauro, Via and Palazzo Vecchiarelli, Tor Sanguigna.
Images and prefigured reality are reciprocally related and the representative model chosen conjugates the two representative codes of orthogonal projection and perspective. The plan identifies the urban fabric "thinning" interventions and indicates the "cornerstones," which are the buildings meant to be the most important morphologic elements of the urban structure.
The composition of the "*Quadri*", that is, the control of the new figurative and perceptive values consequent to the prefigured intervention of modification of the urban environmental context, is entrusted to the perspective views created by the skillful hand of Arturo Viligiardi.
There is no doubt of the representation's technical quality, that even gains an artistic value in the case of the perspective views. The model is surely the iconic herald of symbolic values as it aims at transmitting a mental image of

Fig. 1. Reconstruction of the panel exhibited at the Roman topography exhibition in Castel Sant'Angelo in 1911. Gustavo Giovannoni (1873-1947), Proposal of restoration for Via dei Coronari and its surroundings. Arturo Viligiardi (1869-1936), Perspective views, ink on paper: Perspective sketch of Palazzo Montanara, 18x23; Elevation sketch of Palazzo Montanara, 18x23; Perspective sketch of Palazzo Vecchiarelli's internal court, 12x24; Perspective views of Via dei Coronari and Via dei Vecchiarelli), 42x27. CSSAr Centro di Studi per la Storia dell'Architettura di Roma - Archivio Disegni Gustavo Giovannoni, 43, Quartiere del Rinascimento, Roma, 1911/1935, [c.1.43, 2- 6].



beauty, the "artistic atmosphere" of the urban space; and, properly correlated with the essays, it has a great level of narrativity and communicability.
But the model of representation does not allow operative interactions, and it only suggests perceptive and interpretative values. In fact, it is important to understand that the observer is not one external from the reality represented (the visitor at the exhibition), while he is functional to that representation, crystalized by the choice of that specific perspective point of view.
«The image, as well as each text, in fact, builds inside itself, beyond the contents that it represents, the simulacrum of its spectator, the abstract projection of its receiver. Who is not an empirical recipient but his simulation within the text» [Marrone 2015].

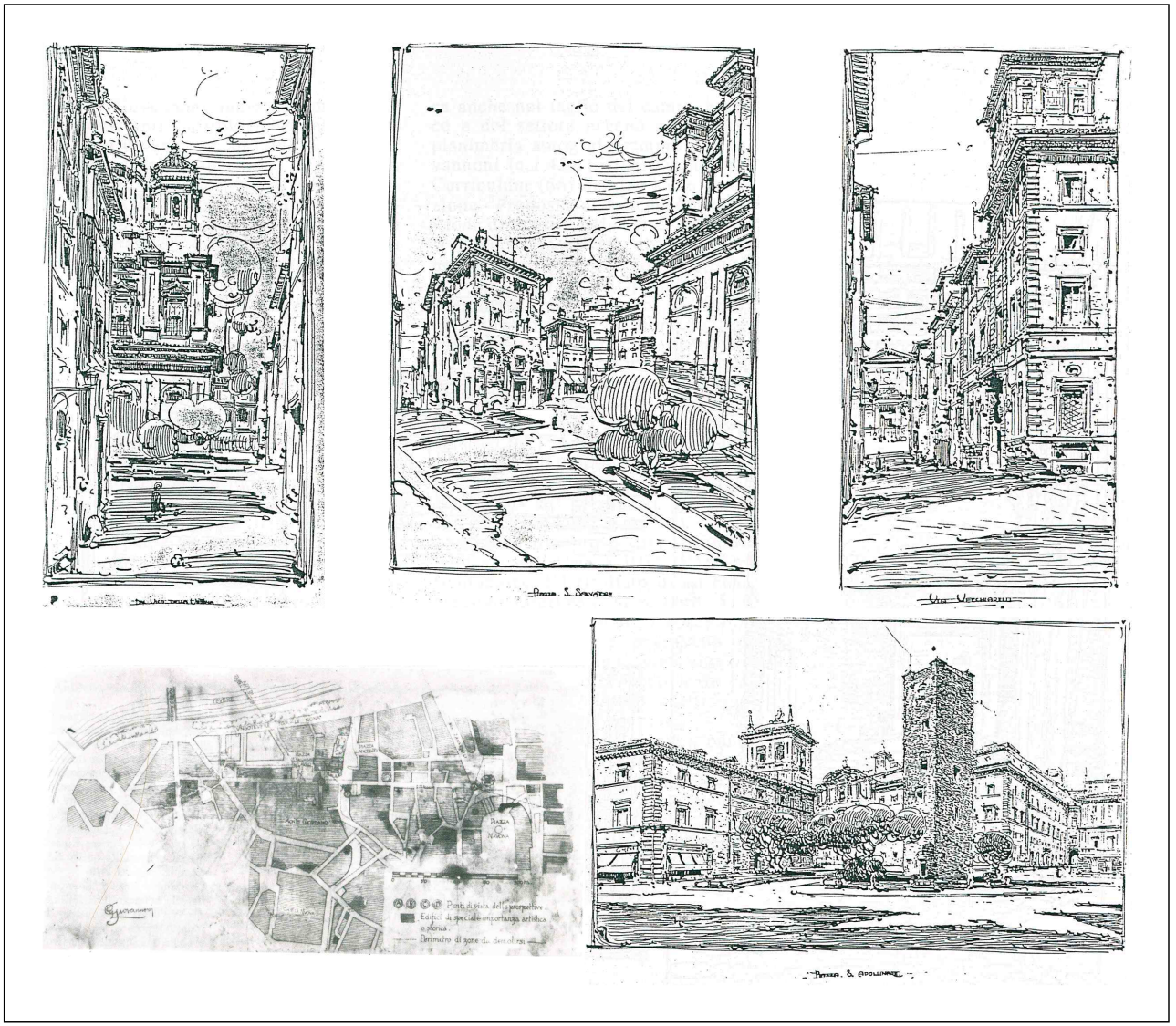
The digital model of representation

The "digital model" covers all the possible models, from the iconic to the non-iconic ones, associating the modes of emulation replica, of dissimulation, of mathematical formalization [Maldondo 2015 (1994); Gaiani 2016]. The digital model has all the prerogatives of the "traditional model of representation" together with important added values, which are interactivity and alterability, because it can be object of analysis, simulation, prefiguration, experimenting, as, for instance, the verification of technical plausibility and organizational and functional adequateness of projectual interventions, which are beyond the model, on reality itself. It supplies quick survey and modeling procedures, even automatic ones, with high precision, exhaustivity of information, similarity with the observation object.
Its immersiveness (model browsing) and augmented reality overturn the external observer's condition, on both an experiential and conceptual level, as a certain degree of autonomy in the choice of the immersive route is possible, to the point of actually interacting in augmented reality, without necessarily being connected to a monitor, but being able to count on friendly devices (smartphones, tablets, wearables…) that favor the logic of immediate transparency.
The "digital model of representation" concept itself gains complex connotations: on the one hand, the data system, on the other hand, their visualization, both based on spatial logics [Brusaporci 2017].
"Immediateness" is conjugated with the characteristic of "hyper-media." The "model of representation" is a "digital environment system" in which the three-dimensional spatial model conjugates a corresponding integrated database, in its constitution defined by a succession of heterogeneous data and information (text, graphic, video, sound, etc.), structured on multiple visualization windows.
«Unlike a perspective painting or a three-dimensional computer graphics space, these windowed interfaces do not attempt to unify the space around any one point of view. Instead, each text window defines its own verbal and graphic window with its own point of view» [nCh'ng 2015, pp. 32, 33].
Operational interactive interfaces are the place in which "visual computing" becomes an interrelation and interpretation of information, and where information becomes knowledge. The most important consequence deriving from this is: the concept of visualization changes, meaning that it is no longer a product but qualifies itself as a process [Bolter, Grusin 1999].

Scientific method and quality standardas

Another crucial node related to methods, procedures and techniques is still to be solved.
A first level regards the survey process [Bianchini 2012; Docci 2016; Docci, Bianchini 2016] [2], even considering the specific distinction between traditional survey procedures and photo-modeling procedures on a photographic base [Gaiani 2015; Apollonio, Gaiani, Foschi 2016], to the one, with active sensors, of 3D laser technology: «The rigorous definition of the survey process (whether traditional or advanced) allows the defining of a procedure that is replicable separately by different researchers in order to verify a specific result: with this, the operation is brought back to the field of scientific research» [Docci, Bianchini, Ippolito 2011].
Again: «survey represents […] a powerful means of scientific investigation […] but it has to be used correctly, keeping in mind the inescapable subjective contribution, which characterizes the discretization phase (to be explicitly declared in the survey project…) and the need of proposing, together with results, the 'raw' data on which such results are based and especially the punctual discretization of the methods and tools used» [1Docci, Bianchini, Ippolito 2011, p. 39].
A second level regards the "model of representation" for which quality standards should be defined in terms of: iconic character and sign structures; formal and technical

Fig. 2. Reconstruction of the panel exhibited at the Roman topography exhibition in Castel Sant'Angelo in 1911. Gustavo Giovannoni (1873-1947), Proposal of restoration for via dei Coronari and its surroundings. Project site plan, 1:2000, 45x26, ink on clear paper, self-made; Arturo Viligiardi (1869-1936), Perspective views, ink on paper: A - Tor Sanguigna square, 35x24; B - New street crossing Via dei Coronari, 22x43; C - Via dei Coronari and Piazza San Salvatore in Lauro, 29x43; D - Via dei Coronari and Palazzo Vecchiarelli, 22x43. CSSAr Centro di Studi per la Storia dell'Architettura di Roma - Archivio Disegni Gustavo Giovannoni, 43, Quartiere del Rinascimento, Roma, 1911/1935, [c.1.43, 6-10].



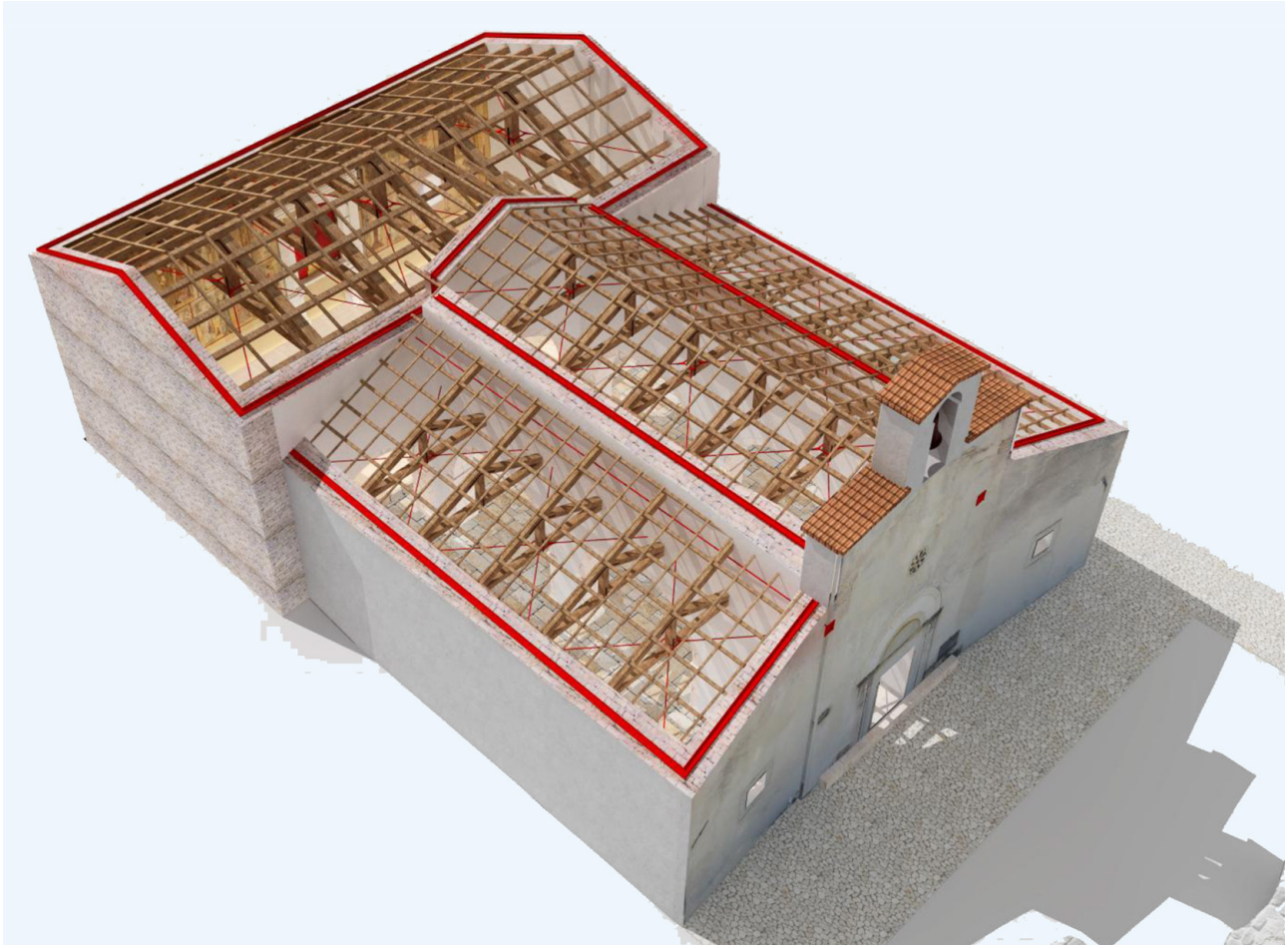
quality; similarity with the object of observation; usability (controlled interaction between user and model); implementation of knowledge in simulated reality; manipulability, technical and semantic interoperability; communication.
Each representative model and the procedure that allowed its generation should carry the characteristics of scientific experimenting: to offer the possibility of repeating the experiment, the eventual proof of "falsification" [Popper 1935], and eventually the possibility of knowledge implementation, starting from the product itself, if scientifically conformed.
But in this sense, a significant reference is represented by the *London Charter for the Computer-based Visualisation of Cultural Heritage*, completed in 2009 after a three-year gestation period [3] and promoted, amongst others, by the *European Network of Excellence in Open Cultural Heritage* EPOCH [4] that at the end of a long phase of elaboration, has triggered an open process of orientation, adhesion, sharing and specialization in several scientific communities [Brusaporci, Trizio 2013]. An ongoing process, as a misalignment between progress in the 3D visualisation of cultural heritage and the development of virtual technologies continues to exist. With particular reference to the articulation of basic metadata, in a transparent manner, and to the digital systems' capability of transmitting the non-assertiveness of critical-interpretative processes in architecture and in history of architecture [5].

The Preamble to the *London Charter* states: «While computer-based visualisation methods are now employed in a wide range of contexts to assist in the research, communication and preservation of cultural heritage, a set of principles is needed that will ensure that digital heritage visualisation is, and is seen to be, at least as intellectually and technically rigorous as longer established cultural heritage research and communication methods. At the same time, such principles must reflect the distinctive properties of computer-based visualisation technologies and methods» [6].
The *Charter* proposes 8 fundamental principles: Subject communities, Aims and Methods, Sources, Transparency requirements, Documentation, Standards, Sustainability and Access.
Excerpts from the *Charter*: «*Principle 2 – Aims and Methods*. […] 2.3. While it is recognized that, particularly in innovative or complex activities, it may not always be possible to determine, a priori, the most appropriate method, the choice of computer-based visualisation method (e.g. more or less photo-realistic, impressionistic or schematic; representation of hypotheses or of the available evidence; dynamic or static) or the decision to develop a new method, should be based on an evaluation of the likely success of each approach in addressing each aim.»
«*Principle 3 – Sources*. In order to ensure the intellectual integrity of computer-based visualisation methods and outcomes, relevant research sources should be identified

Fig. 3. Render. Abbey of Santa Lucia in Rocca di Cambio, L'Aquila (XIV century). Conservation and seismic improvement.
Graduate thesis by Manuele De Vitis. Mario Centofanti (rapporteur), Antonello Salvatori and Stefano Brusaporci (co-rapporteurs), 2016.

and evaluated in a structured and documented way. 3.1 In the context of the Charter, research sources are defined as all information, digital and non-digital, considered during, or directly influencing, the creation of computer-based visualisation outcomes.»
«*Principle 5 – Documentation*. Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed. Documentation strategies should be designed and resourced in such a way that they actively enhance the visualisation activity by encouraging, and hel-

Fig. 4 . Render. Abbey of Santa Lucia in Rocca di Cambio, L'Aquila (XIV century). Conservation and seismic improvement.
Graduate thesis by Manuele De Vitis. Mario Centofanti (rapporteur), Antonello Salvatori and Stefano Brusaporci (co-rapporteurs), 2016.



ping to structure, thoughtful practice. Documentation strategies should be designed to enable rigorous, comparative analysis and evaluation of computer-based visualisations, and to facilitate the recognition and addressing of issues that visualisation activities reveal […].»
«*Principle 7 – Sustainability*. […] where digital archiving is not the most reliable means of ensuring the long-term survival of a computer-based visualisation outcome, a partial, two-dimensional record of a computer-based visualisation output, evoking as far as possible the scope and properties of the original output, should be preferred to the absence of a record.»
Sustainability is linked to the idea that even virtual products are heritage, assets to be transferred to future generations as indicated by the *Charter on the Preservation of Digital Heritage* issued by UNESCO in 2003: «The digital heritage consists of unique resources of human knowledge and expression. It embraces cultural, educational, scientific and administrative resources, as well as technical, legal, medical and other kinds of information created digitally, or converted into digital form from existing analogue resources. […] Many of these resources have lasting value and significance, and therefore constitute a heritage that should be protected and preserved for current and future generations» [7].

A metaphor

In this sense I would like to use, operating a declared conceptual transposition, a rhetoric image linked to the tradition of words that speak of images. The word is rhetorical experience that is other than the perceptive and cognitive experience of images. But our constructions of the architectural model of representation should hold, as a global qualitative attribute, that of *èkphrasis*: «The name that Greek rhetoricians gave to the description of an object, of a person, or to the circumstanced exhibition of an event, and more in particular, to the description of places and artworks with a style elaborated with great virtuosity in order to compete with the expressive strength of the described thing» [8].
The strength of *èkphrasis* lies in the fact that it can survive the disappearance of the described object itself, conserving its memory.
Umberto Eco [Eco, Augè, Didi-Huberman 2015, pp. 11, 12] mentions the episode of the discovery, in January 1506, in an area called the Seven Halls, on the Esquiline Hill in Rome, of the important Greco-Hellenic marble group of the *Death of Lacoon*. The masterpiece was believed lost. But the finders were capable of recognizing it because certain *èkphrases* existed, such as the one written by Pliny the Elder in *Naturalis Historia* [9].

Conclusion

I would like to conclude by repeating a cornerstone of the *London Charter*, which in the first *Principle* states: «1.1. Each community of practice, whether academic, educational, curatorial or commercial, should develop London Charter Implementation Guidelines that cohere with its own aims, objectives and methods.»
According to this orientation, in 2011 the *International Forum of Virtual Archaeology* has elaborated, in implementation of the *London Charter*, the Seville Principles, which discipline the efficiency of the best practices in "archaeological visualisation," based on computers for the complete management of archaeological heritage [10].
In skimming over the stated principles, we find an emphasis on significant, interesting aspects, given that in the Drawing sector there are many qualified contributions dedicated to architectural survey. But also because there are important analogies with architectural survey from the perspective of procedures and techniques.
The eight principles set forth are:
1. Interdisciplinarity;
2. Purpose;
3. Complementarity: «The application of computer-based visualisation for the comprehensive management of archaeological heritage must be treated as a complementary and not alternative tool to other more traditional but equally effective management instruments.»
4. Authenticity: «Computer-based visualisation normally reconstructs or recreates historical buildings, artifacts and environments as we believe they were in the past. For that reason, it should always be possible to distinguish what is real, genuine or authentic from what is not. In this sense, authenticity must be a permanent operational concept in any virtual archaeology project.»
5. Historical rigour;
6. Efficiency;
7. Scientific transparency: «All computer-based visualisation must be essentially transparent, i.e. testable by other

researchers or professionals, since the validity, and therefore the scope, of the conclusions produced by such visualisation will depend largely on the ability of others to confirm or refute the results obtained.»
8. Training and evaluation: «When computer-based visualisations are intended to serve as an instrument for archaeological research and conservation, the most appropriate archaeological evaluation method will be testing by a representative number of end users, i.e. professionals. The final quality of any computer-based visualisation must be evaluated based on the rigor of the measures and not the spectacularity of its results. Compliance with all the principles will determine whether the end result of a computer-based visualisation can be considered or not 'top quality'.»
In the direction indicated by the *London Charter* and the *Seville Principles*, our scientific Community could take charge of internationally promoting the definition of principles for both digital and traditional architectural survey and modeling. Along the routes of a specificity necessary because architecture, historical city, historicized city, urban landscape, and landscape/territory show much more complex problems. It would be an important passage to aim at higher levels in the quality of our area's scientific research, and especially for its fundamental new orientation towards interdisciplinarity and internationalization.

Notes

[1] Arturo Viligiardi (1869-1936), painter, sculptor, architect.

[2] For reference about fundamental studies and research on architectural survey within the Drawing segment, see the paragraph Centofanti 2010b, pp.10, 11.

[3] *London Charter for the computer-based visualization of cultural heritage*: <http://www.londoncharter.org/downloads.html> (accessed 2018, March 21).

[4] EPOCH - *European Network of Excellence in Open Cultural Heritage*, financed by the European Commission, EU. Aim of the network is to supply a clear organizational and disciplinary frame to increase the efficiency of the work at the interface between technology and cultural heritage of the human experience represented in monuments, sites and museums. This frame includes all work processes and streams of information.

[5] *The Future of the Virtual Past: Prospects for the 3D Visualization of Cultural Heritage and Archaeology*. Workshop, 23 February 2017, convened by Dr Donald Cooper in the University of Cambridge's Faculty af Architecture and History of Art.

[6] *London Charter for the computer-based visualization of cultural heritage*: <http://www.londoncharter.org/downloads.html> (accessed 2018, March 21).

[7] *Charter on the Preservation of Digital Heritage* (UNESCO, 2003): <http://portal.unesco.org/en/ev.php-URL_ID=17721&URL_DO=DO_TOPIC&URL_SECTION=201.html> (accessed on March 21, 2018).

[8] Definition from the Treccani online encyclopedia: <http://www.treccani.it/vocabolario/dizionario/> (accessed 2018, March 21).

[9] "The reputation of some, distinguished though their work may be, has been obscured by the number of artists engaged with them on a single task, because no individual monopolizes the credit nor again can several of them be named on equal terms. This is the case with the Laocoon in the palace of the emperor Titus, a work superior to any painting and any bronze. Laocoon, his children and the wonderful clasping coils of the snakes were caned from a single block in accordance with an agreed plan by those eminent craftsmen Hagesander, Polydorus and Athenodorus, all of Rhodes", Pliny's *Naturalis History*, XXXVI, 37, translated by D.E. Eichholz (vol. 10) published by Harvard University Press, Massachusetts and William Heinemann, London; 1949-54.

[10] <http://smartheritage.com/seville-principles/seville-principles> (accessed 2018, March 21).

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San Félix de Torralba de Ribota; Geometric Characterization of Fortified Churches

Luis Agustín-Hernández, Angélica Fernández-Morales, Miguel Sancho Mir

Abstract

In the mid 14th century, between 1356 and 1369, during the so-called "War of the two Peters" in Spain, small churches were built in a series of border enclaves, such as the Church of Santa María in Tobed, the one of San Martin in Morata de Jiloca and San Felix in Torralba de Ribota. Those churches would form part of a new typology called Fortified Churches, "because of their strong military character, provided by their compact external volumes, and their towers-buttresses" [Borras Gualis 2006].
The aim of research is the formal definition of an architectural typology with a high level of heritage interest. Virtual construction, through the combination of photogrammetric and laser scanning techniques, made it possible to achieve an accurate survey on which to make graphic analyses with the required precision, thereby obtaining the regulatory outlines used for the architectural design of the building.
The precision obtained is of great interest in characterizing the shape, especially the curvature of the arches, the plements and other non-rectilinear elements, in order to generate a comparable database.

Keywords: Mediterranean Gothic, Strength-Churches, Laser Scanner, Photogrammetry, Geometric characterization arcs.

Introduction

In the mid 14th century, between 1356 and 1369, the so-called "War of the two Peters", occurred between Peter I "the Cruel" of Castile, and Peter IV "the Ceremonious" of Aragon. The war originated from a dispute over the control of Murcia, and hence the Aragonese supremacy in the western Mediterranean. It came within the European Hundred Years' War, between England and France. Castile had the support of Genoa, aligned within the English area of influence, and the Crown of Aragon was allied with its Italian territories within the French sphere, which represented a war at the continental level and of multiple interests.
This war did not develop constantly with battles, but it was more discontinued over time. It caused battles and conquests in bordering territories between both kingdoms, particularly in the Kingdom of Valencia and Aragon, in the areas of Alicante, Valencia, Teruel and in the Calatayud-Tarazona area. This latter area was of particular significance in the defence of the Kingdom, the control of the valleys of Jalón and Jiloca, which were natural access routes between Castile and Aragon. Hence, Peter IV ordered the important municipalities of Calatayud, Ariza, etc. to be fortified. He also obliged the locations that could not be fortified, to be abandoned, so as not to give advantage to the Castilian troops in the event of a possible military campaign, as the city of Tarazona had fallen to Peter I. The main destination for people from all locations considered unprotected

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or impossible to defend was Calatayud, where in spring 1357, the arrival was expected of inhabitants from Torralba de Ribota, Aniñón, Cervera de la Cañada, Clarés, Vadill, Viver de la Sierra and Embid de la Ribera [Lafuente 2009, p. 540].
In this context, outstanding Aragonese figures and Military Orders collaborated with Peter IV, defraying the construction of small churches in a series of border enclaves. Some of the most outstanding were the Church of Santa María in Tobed, San Martin in Morata de Jiloca and San Félix in Torralba de Ribota. This work is focused on the latter church.
These small churches would form part of a new typology called Fortified Churches, "because of their strong military character, provided by their compact external volumes, and their towers-buttresses" [Borrás Gualis 2006, p. 301]. They are factories built in the Gothic-Mudejar style, and are based on a layout of a single nave floor and side chapels, which house the towers-buttresses. An outside gallery was built on the side and head chapels on the main floor, to be used as a sentry path. It should be noted that in spite of the name, only a limited defensive capacity can be observed (fig. 1).
They have three features that make them prominent: the first is that military orders participated in their construction and were the custodians of the building; the second feature is the construction by converts such as Mahoma Rami or Mahoma Calahorri; and the third is the typology and construction resources used, as the buildings were made in a brickworks, hence the most "industrialized" materials of the age, as well as cheap and fast in areas lacking stone for construction, were used.
The first historic-artistic study on the church of San Félix of Torralba de Ribota, is the article entitled Iglesias gótico-mudéjares del arcedianado de Calatayud, by José María López Landa (Calatayud, 1878-1953), published in the Arquitecura magazine in 1923 [Borrás Gualis 2011, p. 65]. This text quotes the decree in 1367 by Bishop Pedro Pérez Calvillo, ordering the construction of a new church to replace the old parish church destroyed in the war of the two Peters [López Landa 1923, pp. 126]. The document allows an approach to the dating of the original wall of the church, together with another heraldic-type data, the weapons of the Bishop of Tarazona, Juan de Valtierra (1407-1433), placed in the high chorus.

The ground floor is a single nave with a straight apse and rectangular floor, which forms a single interior space, covered with a combination of single ribbed vaulting and small sections of pointed barrel vault. Their generatrix outline is the perpend arches of the ribbed vaulting. Structurally, the thrust caused by the vaults are absorbed by the perimeter towers-buttresses, three on each side

Fig. 1. Exterior side view of the church of San Félix de Torralba de Ribota. Photograph of the authors.

of the nave. The straight head wall is formed of three chapels, covered with a single ribbed vault, and linked with side chapels. The "paso de ronda" (sentry path) goes above the side chapels, the three head chapels and crosses the choir. A large rose window was constructed over the choir, and the main door opens underneath. The whole building was in brickwork, with the interior coated and decorated in pressed brick and polychrome painting of geometric objects. The windows on the upper floor were built with great decorative richness, in structural plaster from the workshop of Mahoma Ramí. [Borrás Gualis 2011, p. 87].
The construction period is limited between 1367 and 1433. With this information and a typologic and formal analysis, Gonzalo Borrás [Borrás Gualis 2011, pp. 84-88] proposes two construction periods in a way that the first one, dated in the last quarter of the 14th Century, would represent the construction of the whole masonry of the church, probably a Master Mahoma Calahorri's work; except for the most occidental module, which closes the church together with the main façade and the two side towers, that would belong to the second period around 1420, work attributed to the Master Mahoma Rami.

Fig. 2. Interior view of the nave of the church of San Félix de Torralba de Ribota. Photograph of the authors.

The study of ribbed vaults and their geometric layout is of special importance for the study. Accepting the main role of the nerves to the formal definition of a ribbed vault, the importance of an accurate geometrical analysis is essential to know the nature of the designs. As Willis already pointed in the 19th Century [Willis 2012 pp. 25, 34], it is desirable to find out the accurate curvatures of the nerves because they are the result of different rules to get geometric centres and radios according to time and nationality of different schools.
This claim supports the necessity to define accurately the geometry of the vaults to be able to analyse the regulating lines and check if they differ in relation to its authorship, materiality and other aspects –although it has been asserted that materials and technics did not define any shape generator of a style in Aragón [Ibáñez 2008, p. 44], it has to be confirmed through an accurate geometrical analysis. The lack of this kind of surveys justifies the interest for this research, which is part of a larger and more ambitious project where it is expected to obtain results impossible to be achieved with the analysis of individual cases (fig. 2).
There is documentation on a significant number of interventions on the original factory between the 18th, 19th, 20th and 21st centuries [Borrás Gualis 2011, pp. 71-73]. Owing to its significance, it is important to highlight the intervention of the first half of the 18th century, which included blocking off the main entrance to accommodate a choir which projected on the ground floor, with a polygonal closure. A semicircular arch was made as the new entrance to the temple, located on the Gospel Side. Time would have an impact on the state of the building, mainly as a result of urgent problems of damp, owing both to leaks and capillarity processes.
As a result of this unsustainable situation, it was decided to intervene. From 1953 to the sixties, Fernando Chueca Goitia took charge of the restoration of the church, intervening in various stages [Hernández Martínez 2012 pp. 13-26]. The roof structure was fully replaced, and it was attempted to return the construction to its unitary nature of the original typology. The lower choir was demolished, which had been added in the baroque period, and which blocked the original entrance. The arches of the outside galleries were opened and all elements that had been practically lost

Fig. 3. View of the digital sectioned model. Own elaboration.

Fig. 4. Plan view of the digital model at + 4.00 m. Own elaboration.

were restored (or reconstructed). These included the rose window of the main façade, carved in gypsum. New elements were even added such as the ligneous eaves covering the baroque entrance.
In the last quarter of the 20th century and the beginning of the 21st century, work was performed by the architect Joaquín Soro [Borrás Gualis 2011, pp. 73-78], chiefly directed at solving the endemic problem of damp, and its serious consequences on the structure and decoration of the temple.
The aim of research is the formal definition of an architectural typology with a high level of heritage interest, through the precise documentation of buildings studied. Virtual construction, through the combination of photogrammetric and laser scanning techniques, has made it possible to achieve an accurate survey on which to make graphic analyses, with the required precision, thereby obtaining the regulatory outlines used for the architectural design of the building. This will enable a comparative study of the traces used in the different buildings of the typology. The survey process chosen also enables a suitable record of other formal aspects, which characterize the building under study, such as the valuable pressed brick and painted decoration, or the outstanding moveable property heritage of the temple [Lacarra Ducay 2011, pp. 105-162] within its context.

Methodology

Before tackling the field work, an assessment was done on the state of the studies concerning the building under analysis. This work had to be based on the documentary study of the revision of different archive and bibliographic sources. Fortunately, the San Félix Church of Torralba de Ribota has been researched from various viewpoints, as thorough historic and artistic studies have made it possible to tackle the analysis raised with sufficient basic guarantees.
The study of documentary sources is essential to evaluate the authenticity of the dimensional elements and values to be recorded. It has therefore been of particular importance to know the documented actions on the building. However, it is considered necessary to complement it with the critical, on-site analysis of the building using wall stratigraphy, to contrast the authenticity of data to be taken.

After this phase, there is sufficient knowledge to plan the field work, which is essential to collect effective data As Gil [Gil 2016, p. 46] explains, the selection of the survey method of the building will depend on factors like the type of monument or the level of detail required. When millimetre detail is required along with documenting large areas, it is advisable to use a laser scanner, for its convenience and speed. Photogrammetry is a more economical and efficient process and is recommended for individual elements, such as columns or statues. To record roofs and ceilings, close-range aerial photogrammetry is recommended with the help of a drone.

In this case, the survey of the building was carried out using a combination of laser scanning and close-range aerial photogrammetry. With the combination of both, a complete model of the outside and inside of the building was achieved.

A Faro Focus3D X 130 laser scanner was used, with a range of between 0.6 and 130 m., which enables a distance accuracy of up to ±2 mm. Fourteen stations were made: four inside, one inside-outside (at the door threshold) and nine outside. The density of the point cloud was 6 mm., and not only volumetric information was collected, but also colorimetric, in order to register the materials and paints of the building. The scanner, therefore, was able to take data from the inside and from all the façades.

A DJI drone was used for the photogrammetric register, with its own integrated DJI camera, model FC350, with a focal distance of 20 mm. (wide angle), and a fixed diaphragm aperture of 2.8. Photographs of 4000 x 2250 pixels were taken, the majority at an oblique angle. This enabled a fairly good capture, not only of the roof, but also of the façades, in this case from a high level, unlike the scanner. The 96 photographs used were processed with Photoscan software, and a cloud of 4,700,000 points was obtained, which was limited to the +10m level of the building, taking level 0 as the ground level inside the church. Information of the façades under +10m was hence entrusted only to the laser scanner, as it is more detailed.

The combination of information from the laser scanner and the photogrammetric process, a total of fifteen cloud points, was done with Autodesk Recap software. Firstly, all scanner stations were loaded, and were referenced between them, using common points,

Fig. 5. Aerial view of the digital model. Own elaboration.

Fig. 6. Floor plan obtained from the digital model. Own elaboration.

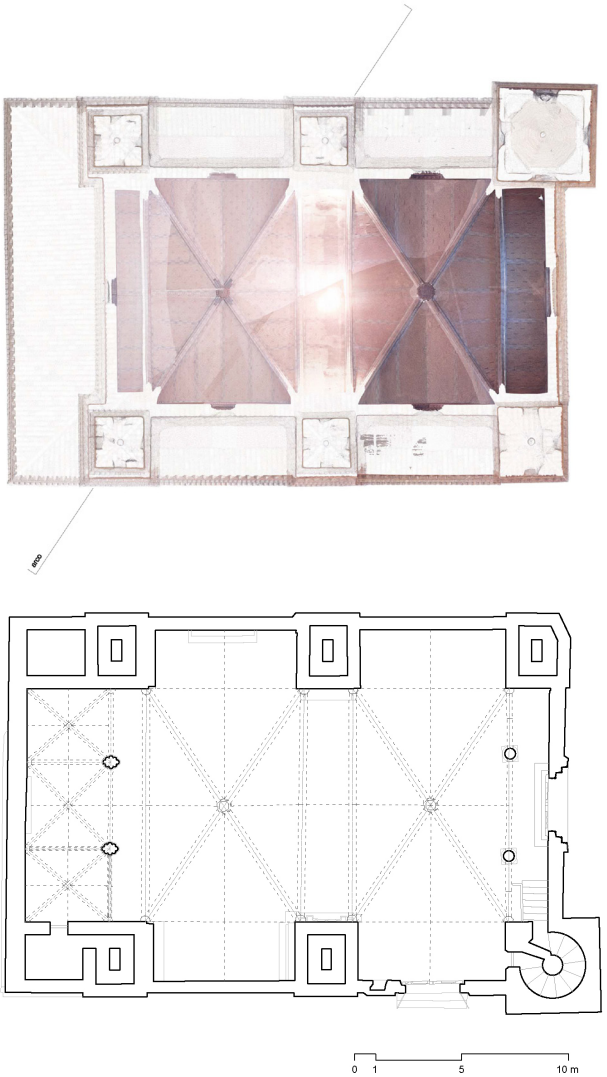

Fig. 7. Longitudinal sectional view of the digital model. Own elaboration.

in a process which Recap helps to do quite automatically. The coordinates of several significant points of the model were noted, and in Photoscan, these coordinates were allocated to the corresponding points in the photogrammetric cloud, obtained from the photographs of the drone. In this way, the photogrammetric model was directed and scaled, to accurately match the information of the laser scanning. Lastly, this point cloud was imported to Recap, along with the others, attaining a perfect overlap.
The advantage of Recap software is that the resulting files are easily integrated into other 3d programmes, for their display, to obtain views and combine with other models. In this case, the AutoCad programme was used to obtain the required views, by applying rectangular cuts to the point cloud.
With previous knowledge on the architectural typography to be analysed, along with its construction system, once the three-dimensional model was obtained, it was decided which traces and dimensions are the ones that define it. This process is of utmost importance, as it enables a comparative analysis to be done between the documented property, the first case of the study and the following ones, which will form part of wider, longer and more ambitious research (fig. 3).
In this case, the accurate documentation of the trace and proportion of the arches that define the structure of the building, were particularly significant, such as the diagonals of the single ribbed vaults, or perpend arches, along with the arch of the pointed barrel vaults of the side chapels.
To obtain the ground floor and the central floor, horizontal cuts were made at different heights, and upper and lower views were generated. To obtain longitudinal sections, vertical cuts were made taking the roof axis as a reference. An oblique vertical cut was also made in the axis, through one of the arches of the ribbed vault of the head, in order to learn the real geometry of this arch. All views were generated at a scale of 1/100 (figs. 4-6).
The sections obtained directly over the three-dimensional model were used as the basis for redrawing them. This method enabled the regulator geometry outlines to be obtained, and to go into more depth on the knowledge of the building, as the drawing, which is an analytical process, enables and requires intense contact with the studied reality (figs. 7-10).

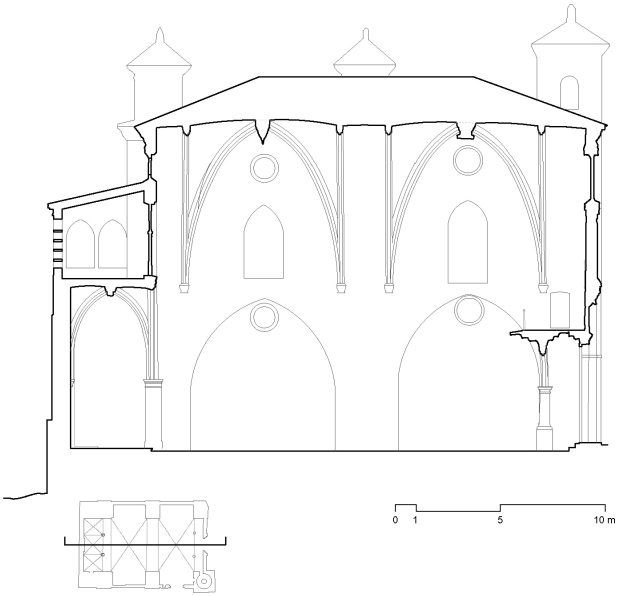

Fig. 8. Plan of the longitudinal section obtained from the digital model. Own elaboration.

Results

As a result of the work and the methodology described, graphic material of a diverse nature was generated. The photography required for the photogrammetric survey is an extremely interesting result in itself, particularly capturing images with a drone, as it is documentation that was not available until now.
The three-dimensional model obtained by combining the data generated by laser scanner technology and photogrammetric processing, contains complete geometric information of the building. Moreover, it records the colour values obtained from photographs used in the process.
Lastly, the graphic analysis made by the selected planimetry delineation, has enabled a large amount of data to be obtained, of which we explain the most significant. The volume of the church is entered in a solid capable of 27,76x 18,67 x 27,84 metres. The maximum height of this volume is determined by the tower located at the foot of the temple, on the Gospel

Fig. 9. View sectioned by the arch of the ribbed vault of the digital model. Own elaboration.

side, and has a floor of 4,44 x 4,42 metres. Inside the temple, the structural system adjusts and provides a space of 24,39 x 16,36 x 15,76 metres, with the height delimited by the position of the keystones of the single ribbed vaults of the central nave. These vaults cover a floor space of 7,30 x 10,87 metres and the crossing arches, that form them, have a rise of 7,86 m and a span of 12,93 m, which means a slenderness ratio of 1/1,64. The perpend arches, which act as a generatrix arch of the pointed barrel vault of the central nave, have the same rise, but cover a span of 10,87 m, hence their slenderness ratio of 1/1.38 , is logically greater. As for the side chapel vaults, covering a space of 2,76 metres in depth, they are defined by a generatrix arch with a rise of 4.20 m and a span of 6.86 m. (slenderness of 1/1.63).
The vaults are simple ribbed shaped, with pointed arches and plane rampant, moulded brick nerves and brick severies as well. The side arches severy encounters the wall assembling an edge instead of a nerve. As said, the vault covers a span of 10.87 m and a bay of 7.30. Accordingly, the floor plan proportion is practically sexquialter (3:2), one of the most frequent in Gothic Style (Palacios 2009 pp. 86-87). The cross rampant, slightly curved and sloped, has a difference of 55 cm high (straight slope =10,7%), while the rampant spine, with the same formal definition, has a difference of 23.4 cm high (straight slope = 7,4%). The side arch is very cambered with a centre 2.68 m far from the impost line, in contrast to the diagonal nerves and the Perpignan-arches, with the centres emplaced very close although always under it, with the diagonal a little bit farther (33.9 cm), and with one curved practically similar. All the nerve curvatures are circumference segments have been traced with a maximum tolerance of 2.1 cm in the middle points.

Conclusions

The various graphic materials generated in the research- the photographic information, the three-dimensional virtual model and the later delineated and graphic analysis- complement each other to obtain the correct formal characterization, defining the geometry, but also the associated color values that determine the true image of the monument.

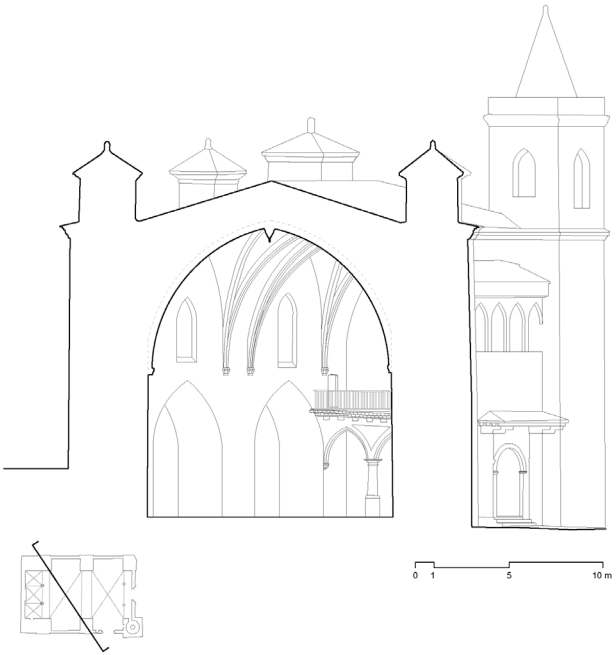

Fig. 10. Plane of the longitudinal section of the cruciate arch obtained from the digital model. Own elaboration.

As a consequence of the methodology used. it was possible to corroborate the importance of a detailed planning of the different stages, for which a previous knowledge of the heritage object is necessary. This is the only way to avoid duplication of efforts in data collection, or the use of improper data, among other errors that could be crucial to the results obtained. In addition, the comparison between the plans and drawings generated by us and those previously made by others revealed an important difference in the geometries represented. The precision obtained with the method used is therefore of great interest in characterizing the shape, especially the curvature of the arches, the plements and other non-rectilinear elements.
Finally, in order to generate a comparable database, which allows for further analysis, it is necessary to establish a data standardization, which enables their interoperability. Those conditions proved to be essential for a valid methodology for the formal characterization not only of a church, but also of the typology itself.

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About the 'Cape'. Considerations on Geometries of the Maurizio Sacripanti's Osaka Pavilion Roof

Lorena Greco, Maria Laura Rossi, Marta Salvatore

Abstract

This study focuses on the interpretation of the shape of double curvature surfaces, which characterize the morphology of unrealized architectural projects, particularly interesting from the point of view of shape. The analysis of architecture, carried out by means of analogical instruments proper of the tradition of drawing, today finds a fruitful experimentation field in digital space and a privileged place for studying and validating the geometrical properties of architectural shape.
The experimented methodology faces the problem of reading architectural surfaces through the control of the respective geometrical properties in the field of continuous tridimensional representation in digital space. The object of the experimentation is the covering of the pavilion designed by Maurizio Sacripanti for the Universal Exposition of Osaka in 1970. It is an emblematic case because of the different interpretations to which the drawings of the 'cape' are susceptible.
Moreover, the interest for this work regards both the geometrical shape of the roof and the idea of movement, which becomes the backbone of a kinetic architecture that transforms technology into architectural language.

Keyword: Maurizio Sacripanti, Italian pavilion, Osaka, cape, kinetic architecture.

Introduction

This study gives attention to the interpretation of the shape of double curvature surfaces that characterize the morphology of unrealized architectural projects.
The analysis of the architecture, which, in the drawing tradition, was conducted by analogical means, i.e. graphically, today finds fertile experimentation in digital space as a privileged place of study and validation of geometrical properties of the shapes of which the architecture is made. 3D modeling had the great merit of allowing the materialization, in digital space, of mental processes of imagination and control of the shape through virtual construction of the models. Gino Loria, in the early nineteenth century, argued that construction is the existential demonstration of shape, and today, as never before, this consideration is topical in relation to the virtual space of a computer [Loria 1935, p. 276]. Today, we can operate directly in space, making use of curves and surfaces with double curvatures towards the solution of problems related to the control of shape. In geometry, in recent years, this operativity amplified the field of experimentation including more and more complex constructions in the classical repertory of problems solvable through a synthetic method, namely through the drawing.
The research of the geometric shape finds fruitful field of experimentation in the architectural design domain, where the properties of lines and surfaces become a design opportunity. At the same time, this research finds a further field of application in the critical reading of unrealized

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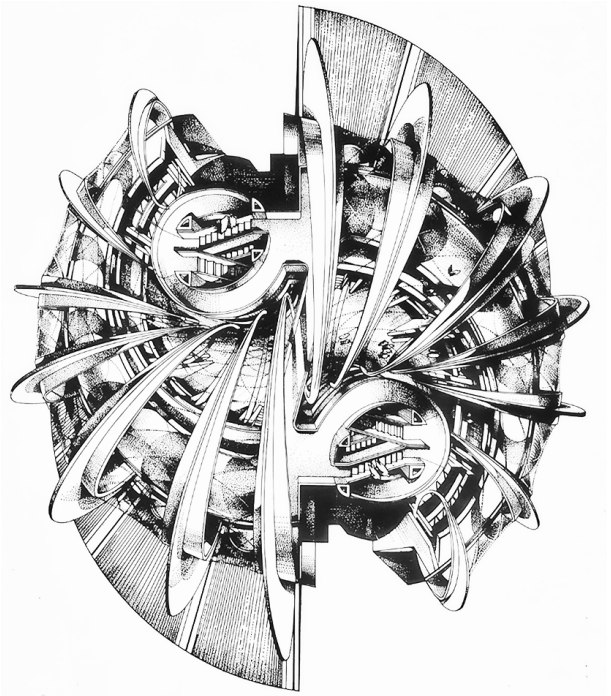
architectural projects, where the identity of the architectural shape is the result of the coherence between its geometric characteristics and its graphic representation.
Sometimes it happens that this congruence is not found. Consequently, this critical reading reveals some ambiguities. This is the case of the roof of the Italian Pavilion that Maurizio Sacripanti designed for the Osaka Universal Exposition of 1970, emblematic because of the different interpretations of which the representations of the 'cape' are susceptible (fig. 1).
The Osaka pavilion is one of the 'kinetic architectures' that Sacripanti designed in the Sixties. Conceived as living organisms, they present particularly articulated spaces, characterized by a certain formal complexity and a marked plasticity.

Fig. 1. Sacripanti Studio, Osaka pavillon perpective, Rome, Accademia Nazionale di San Luca, Archivio del Moderno e del Contemporaneo. Fondo Maurizio Sacripanti. 1968 - Progetto per il Padiglione italiano all'Esposizione Universale Expo '70 a Osaka, n. 11134. <http://www.fondosacripanti.org/elementi_online.php?id=42>.



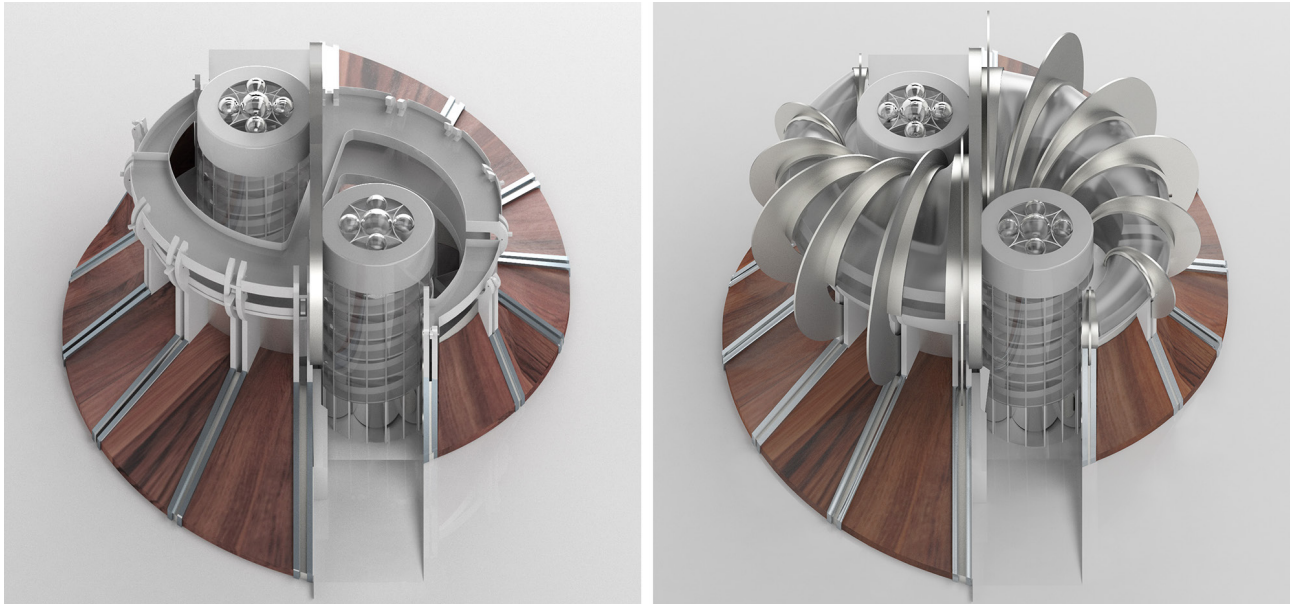
This complexity is not found in the properties of the singular surfaces used; rather it is found through a combination of a set of simple geometries designed, considering 'time' as part of the project from which mechanical variable spaces come to life, animated by movement.
The interest in this work lies in the geometric conformation of the 'cape', as well as in its compatibility with the idea of movement, the driving element of this architecture. A critical reading of the graphical and physical models that came to us reveals some ambiguities. These were the starting point for a series of reflections into the research of a shape as geometric locus, according to the idea at the basis of the architectural project and with the movement of the structure.
Therefore, the 'cape' of Osaka was an opportunity to experiment a methodology aimed at the morphological analysis of architectural surfaces characterized by a particular formal interest, through a process of geometric rationalization that operates in the context of continuous tridimensional representation [1].

The reasons for the 'cape'

The "variability of shapes" and the "changeability of space" [2] are indeed themes that Sacripanti investigated and developed starting from the early sixties, beginning with the design for the Peugeot Skyscraper facing, composed of movable panels, to the structure of the project for the Lyric Theater of Cagliari, inspired by the scenic representation of John Cage's ballets [3]. However, it is in the proposal of the Osaka Pavilion that movement becomes a key element of kinetic architecture, inspired by programmed art that makes technology as a design instrument, transforming it into architectural language.
Conceived as a dynamic expository path, the pavilion is formed by two equal parts, each symmetrical and upside down with respect to the other, composed of two "curved and empty truncated cones reminiscent of each other in their increasing and decreasing trend" [4]. Each of these parts is made by a static structure, a dynamic structure connected to the first one and a membrane system that Sacripanti defines as 'cape' in the technique report (fig. 2).
The fixed core identifies the static scheme of the pavilion and includes the expositive curved walkways; two cylindrical bodies enclose the helicoidal staircases and the installation channels.

Fourteen vertical steel structures are connected to the two towers. These elements are coupled easels that support two series of seven circular-shaped movable metal disks decreasing in diameter, which are tangential to the cylindrical pillars of the staircases.
These disks, independent among themselves, would move rotating around an eccentric center, in their planes, each with its own oscillation, between 0 to 18° for the sixth and seventh disks, and 15° for the other five [5] (fig. 3).
The expositive path would be covered by a membrane, the cape, "very difficult to draw and represent" [Sacripanti 1969, p. 2].
The image of the cape must have been clear to Sacripanti when he drew up the design report: "space and volume are together broken up and rebuilt in the project" [Sacripanti 1973, p. 90]. Thus, the static image of "curved and empty truncated cones" is broken by movement, which transforms the architecture into a place of absolute formal unpredictability, in which the living space is constantly modified by an "infinite combination of the movement of the blades" [6]. This changeability, produced by the introduction of time, and therefore of movement as a design element, had to be amplified by a transparent and iridescent plastic cover, which would have produced ever-changing light effects with each pulsation of the membranes.
Concerning the manner for supporting these membranes, the documents that came to us show different ideas. Thus, the sketches and project drawings, the physical models and the written and verbal testimonies of those who had collaborated with Sacripanti in the architectural project, show a certain ambiguity of interpretation, which affects both the overall shape of the cape and the shape of its support structure.
In the design report, Sacripanti describes: "reinforcing wings perpendicular to the motion plane that carry transparent plastic membranes, whose figurative weaving will be characterized according to a scheme already in development by one of the greatest Italian painters" [7]. We are not sure who was the painter appointed for the design of the 'cape', but the idea of a semi-rigid connection structure between consecutive disks can be found in some of the design sketches [8] (fig. 4).

Fig. 2. Digital reconstruction of the static structure (on the left) and dynamic structure (on the right) of the pavilion.



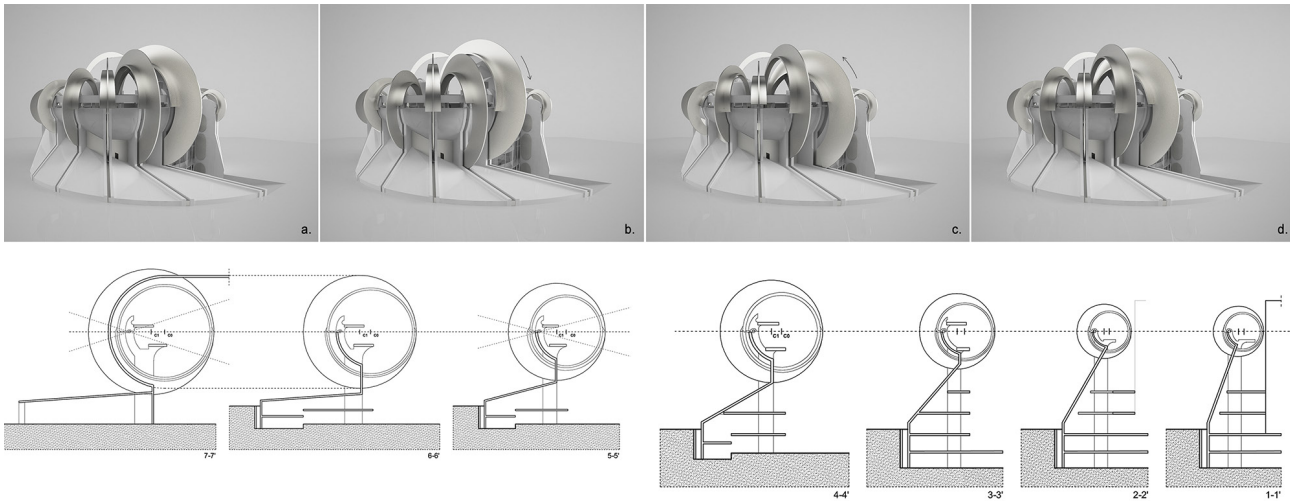


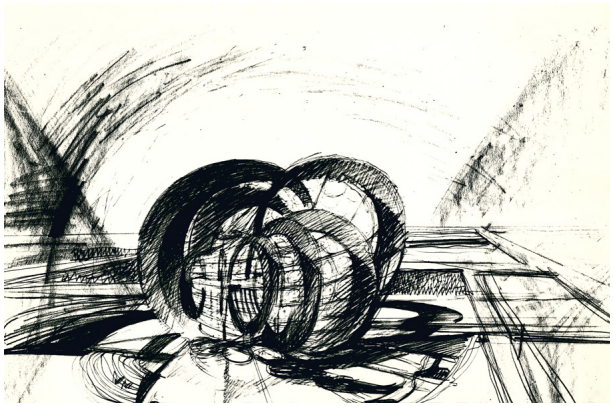
Fig. 3. Digital reconstruction of dynamic structure of the pavilion in the phases of the disks movement, based on design drawings.

Instead, we know that the roof of the pavilion was introduced at the end of the design process and widely debated in Sacripanti's studio because, as Franco Purini recounts, it was necessary to "think about the shell because, when it rains, there was the problem of how to cover it" [9]. Purini describes how a metal network would have to sustain the cape, conceived as a 'dress', placed on a movable structure, an idea that is reflected in the model and in some competitive drawings (fig. 5).
The same competitive tables, in which the net between one disk and the next is represented, do not provide univocal information about the shape of the cape. In fact, the convexity of the 'cape' seen in the plan is not coherent with the concavity of the net represented in elevation.
The changeability of the project must have characterized it also in its first creative phases. Some sketches seem to reflect this idea, as confirmed also by Achille Perilli in his *Testimony* about the entire design process of the pavilion [10]. These reflections were the starting point for some geometric speculation researching a rational form of the cape.The goal is to find, through the geometric digital construction of the surfaces, the reasons for a form that does not have only one definition in the different representations of the project.

The research of the form

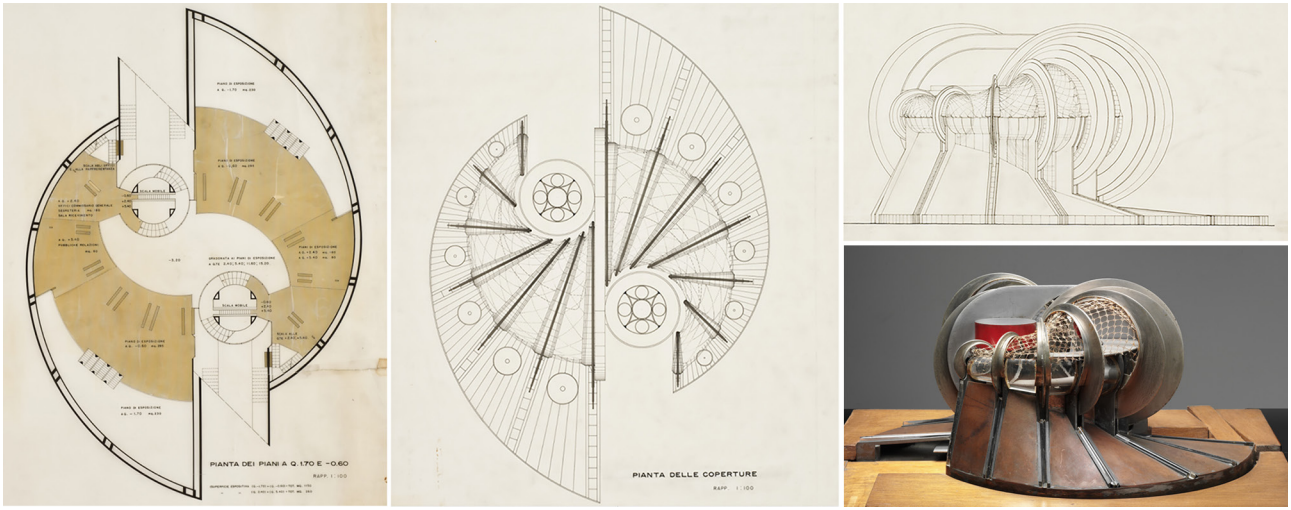
A reading of the 'cape' drawings, mostly preserved at the *Fondo Sacripanti* at the Accademia di San Luca and at the

Fig. 4. Sketch of Osaka pavilion, MAXXI Museo nazionale delle arti del XXI secolo, Rome. MAXXI Architettura Collection, Maurizio Sacripanti Archive, n. F10252.



Collection of XX Century at the MAXXI in Rome, reveals a continuously evolving form, variable since the early stages of its design process.
The incisive and suggestive images of "curved and empty truncated cones" [11] recall two opposed and rotating parts of a Dupin cyclide [12], a surface that has the appearance of a torus with variable, increasing and decreasing sections. The shape of this surface, that finds application in the design field, is generally known and part of the common visual experience, although its properties are not well known in architecture.
The image of a Dupin cyclide occurs in some design sketches and let us hypothesize that this geometry may have inspired, perhaps from its preliminary phases, the idea behind the shape of the 'cape' (fig 6).
However, the geometrical characteristics of this surface are not compatible with the disposition of the circular blades. In fact, a Dupin cyclide is the locus of circumferences passing through the contact points of a mobile sphere tangent to three given spheres and, like all cyclides, admits only circumferences for curvature lines [13] [Dupin 1822, p. 336; Hachette 1813, p. 442]. Given this surface, it is possible to obtain two series of curvature lines by sectioning them with two groups of planes, one for each series. These planes have as support axes, respectively: the axis of the surface; the straight line intersection between a pair of planes passing through two sets of three contact points between the mobile sphere and the three given spheres (fig. 7).
All other planes intersect the surface according to a fourth order curve, eventually according to two curves of a lower order, but not according to circumferences.
The Dupin cyclide is compatible with the planimetric layout of the project, in particular with its apparent contour, represented in the design of the plan by two eccentric circumferences. However, this interpretation is not coherent with the circular geometry of the metal disks. In fact, the planes of the disks, although they are parallel to the axis of the surface, do not pass through its center, and therefore cannot intersect it according to the circumferences. It follows that if this were a Dupin cyclide, the disks could not be circular and the approximation would be greater as the surface decreases (fig. 8). It is possible, as mentioned above, to hypothesize that the generative principle of the 'cape' shape may have been inspired by this surface, as the sketch

Fig. 5. Project drawings, Rome, Accademia Nazionale di San Luca, Archivio del Moderno e del Contemporaneo. Fondo Maurizio Sacripanti. 1968 - Progetto per il Padiglione italiano all'Esposizione Universale Expo '70 a Osaka, n. 2, 4, 6/34, <http://www.fondosacripanti.org/elementi_online.php?id=42>; architectural model, MAXXI Museo nazionale delle arti del XXI secolo, Rome. MAXXI Architettura Collection, Maurizio Sacripanti Archive, n. MOD43.



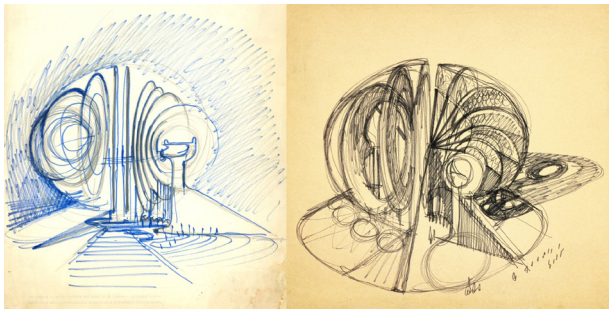
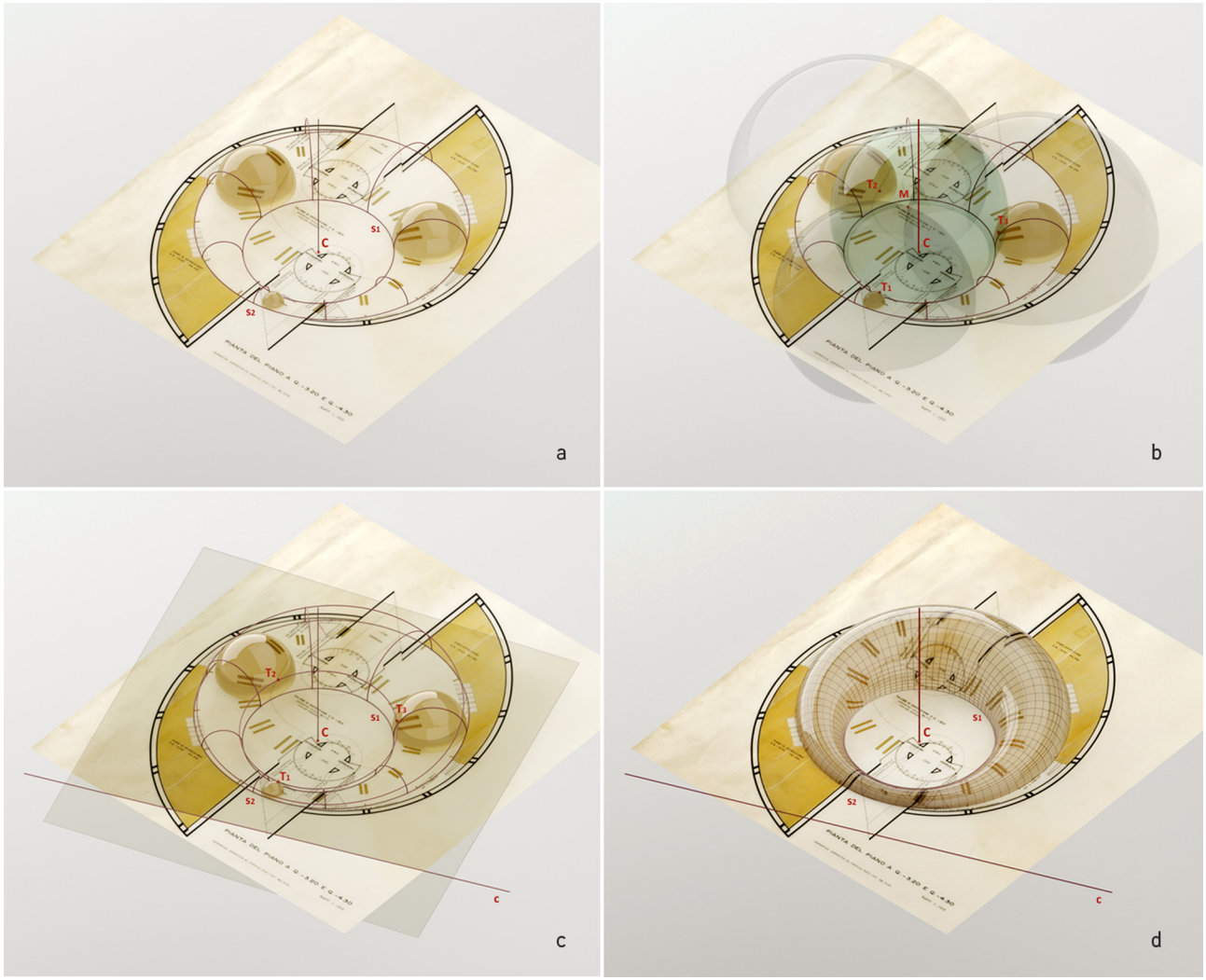


Fig. 6. Sketches of the Osaka pavilion by Sacripanti studio, MAXXI Museo nazionale delle arti del XXI secolo, Rome. MAXXI Architettura Collection, Maurizio Sacripanti Archive, n. 32462, 32464.

in figure 6 would seem to indicate, in which the planes of the moving circles pass through the center of the surface.
The construction of a Dupin cyclide is rather laborious if executed with graphical methods of representation on the plane. Today it is possible to represent this surface with accuracy directly in the digital space starting from their properties, and therefore from the construction of some of the circumferences that form its series of curvature lines [14].
Thus, in the case of Osaka, it was possible to construct this surface starting from the apparent contour of the cape seen in the plan, namely, from a pair of eccentric circumferences that are curvature lines of the first series, which are placed on the symmetrical plane of the surface. The second series of the curvature lines is easily constructed by cutting the assigned pair of curvature lines with the planes which have the axis of the surface as a supporting straight line. In this manner we obtain the pairs of points placed on the outer and inner curves. They are then placed at the extremes of the diameters of the circumferences that describe the second series of curvature lines. The construction of the first series consists of using a mobile sphere with a variable radius which, once in motion, envelopes three given spheres. The three spheres in question are inscribed in the eccentric circumferences of the cape of the pavilion seen in the plan. We establish two configuration types of the movable sphere, which represent two of the infinite positions that this sphere can assume in motion, and which determine two triads of contact points between this moving sphere and the three given spheres. Each of these groups of three points defines a curvature line and a plane that belong to it. The straight line, intersection of the two planes thus obtained, is a support for the group of planes which section the cyclide according to the first series of curvature lines, which is thus determined (fig. 9).
Although there are certain formal relationships between a Dupin cyclide and the cape form, this surface is in no way deformable, and is therefore incompatible with disk movement and consequently with the kinetic requirements of the project.
In order to obtain a shape for the cape compatible with the movement of the structure, it is possible to imagine the membrane as a set of surfaces stretched between adjacent disks.
If, in the case of the cyclide, the surface is suggested by the planimetric drawing, in this second experiment the interpretation is indicated by the elevations. Indeed, the concavity of the cape in elevation would be satisfied by the elasticity of the membrane, which would, however, also characterize the design of the plan. Among the geometric locus surfaces which can satisfy the movement of the structure and the concavity of the membrane, ruled surfaces were considered, whose images are suggested by some design sketches (figs. 4-10).
It is possible to imagine the ruled surfaces whose generatrices, placed between two movable neighboring circles, are elastic or extensible, such as for example a telescopic shaft, which would be compatible with the description of the wings described by Sacripanti in the design report.
Using these ruled surfaces, the rotation of the disks would produce a torsion of the surfaces, extending or contracting the extensible generatrices, while maintaining unchanged their geometric properties. A well-known demonstration given by Monge on ruled surfaces demonstrates how these surfaces are thus defined, when they lean on three directrices [Fallavollita 2009, p. 154, 155]. If these three directrices are curved, the ruled surface is generic. Various types of ruled surfaces, having a different form and a different disposition of their generatrices, can pass through two circumferences generically oriented in space. In the case of a transparent membrane, the disposition of the generatrices conditions the overall image of the project. Imagining the support structure of the membrane as a ruled generic surface would guarantee a division of the disks in equal parts, through which the extensible generatrices of the surface pass (fig. 11).

Fig. 7. Construction algorithm of a Dupin cyclide on the planimetric representation of the pavilion.



Therefore, it is possible to experiment further configurations and hypothesize that the surface leans on two mobile circles and one straight line, which, for example can be reconstructed according to the design traces. In the case in question the straight line passes through the centers of two contiguous disks, the ruled surface is a cylindroid, and the generatrices divide the disks in irregular intervals at a progressive increase (fig. 12).
It is possible to go further, conjecturing that the movable discs were circular sections of an elliptical one-sheet hyperboloid. In this case, the generatrices of the ruled surface would meet the circles of the disks at regular and symmetrical intervals, although different among themselves. It is then possible, within the continuous tridimensional drawing, to represent the disks and the cape by writing of one's generative algorithm. Thus, it would be possible to simulate, in a parametric environment, the movement of the structure, as additional verification of the validity of the formulated hypothesis. Moreover, this kind of algorithm would allow experimentation of the use of minimal surfaces, which would convincingly approximate Sacripanti's original idea [15].

Conclusions

As it was possible to foresee, the experimentation conducted, did not identify a geometric locus form able to contextually satisfy all the obligatory conditions of the project and the movement idea of the structure. The cape was introduced in the final phase of the project due to functional exigencies. Therefore, it is possible to hypothesize

Fig. 8. Sections of a Dupin cyclide obtained by the planes passing through the axis (a), parallel to this axis (b) and by the pavilion blades (c).

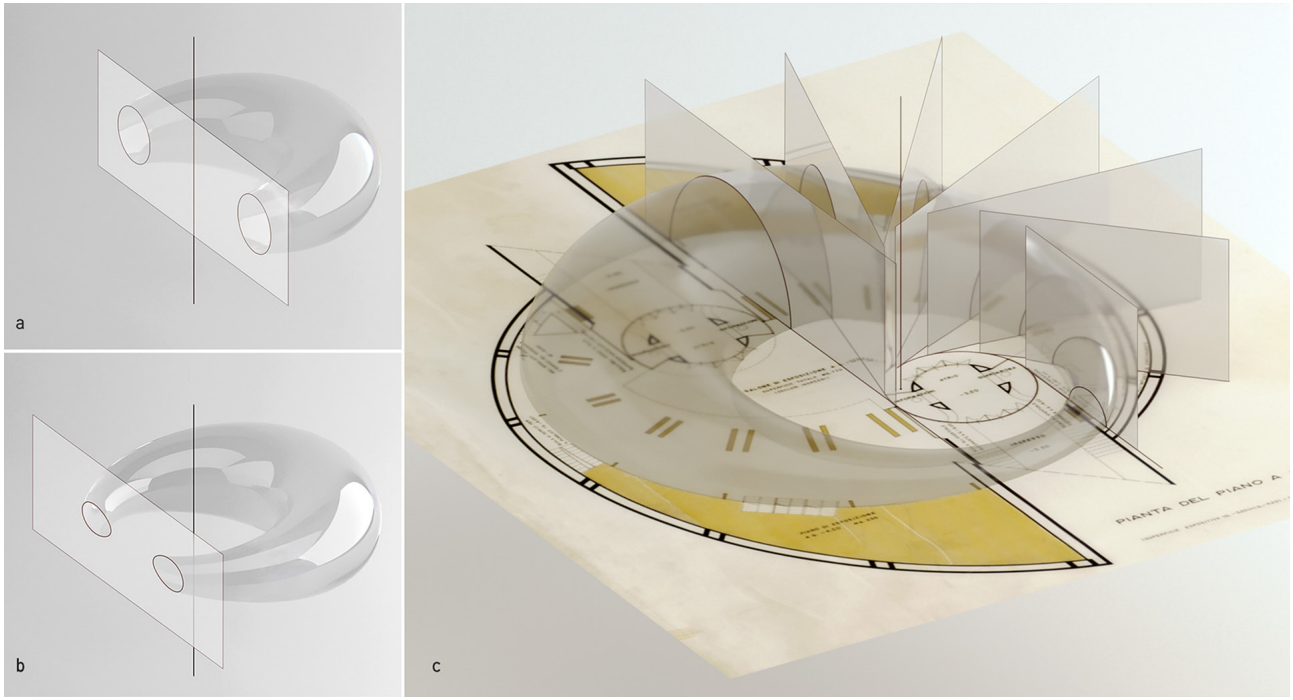
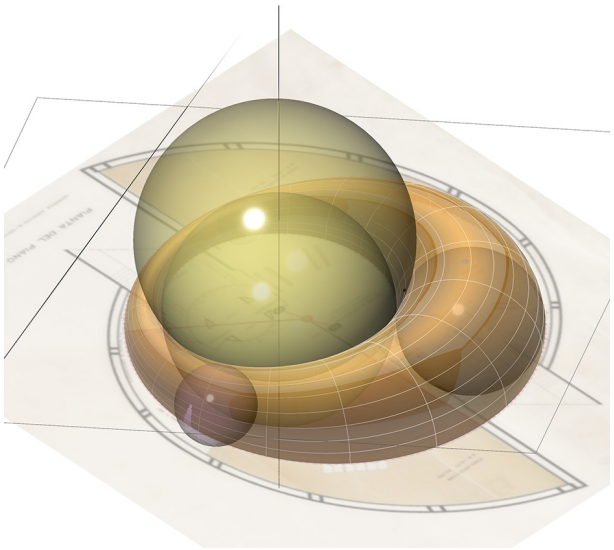


Fig. 9. Geometric genesis of Dupin cyclide starting with its two series of curvature lines.



that, at the time of competition, a clear image of a plastic and iridescent membrane had not yet found an univocal geometric definition. Thus, the drawing of the 'cape' would have communicated, through the image of pulsating membranes, the metaphor of a country in movement despite the difficulties, deferring the problem of the form of the cape to a subsequent phase.
If, on the one hand, this visionary architecture transmitted a symbolic message, on the other, it concretely tested technology, according to a constructive approach characteristic of Sacripanti's projects: "In architecture […] it is necessary to use 'pure thought' through all the pitfalls of reality and various necessities, because people come into the architecture that we create…in this sense it is one of the most difficult arts, otherwise architecture would be like music… Isn't that right? Hence, one invents technique himself. Therefore, technique also becomes a poetic occasion. Every painter has his own technique" [16].
We can therefore imagine that formal definition of the cape, was not found in the competition phases would have been resolved in that constructive phase that never saw the light. Perhaps, in that phase, the architecture would still have been modified, proceeding in a continuous evolution which characterized it from its inception [17].

Fig. 10. Digital reconstruction of the ruled surface and sketch of the Osaka pavilion by Sacripanti studio. MAXXI Museo nazionale delle arti del XXI secolo, Rome. MAXXI Architettura Collection, Maurizio Sacripanti Archive, n. 32465.

Fig. 11. Genesis of the cape as a generic ruled surface and simulation of the movement.

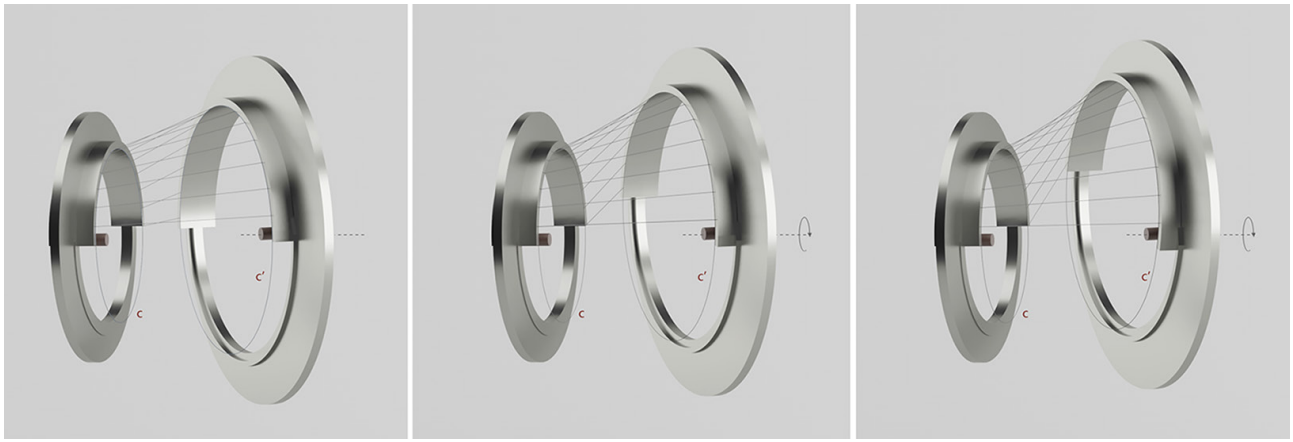
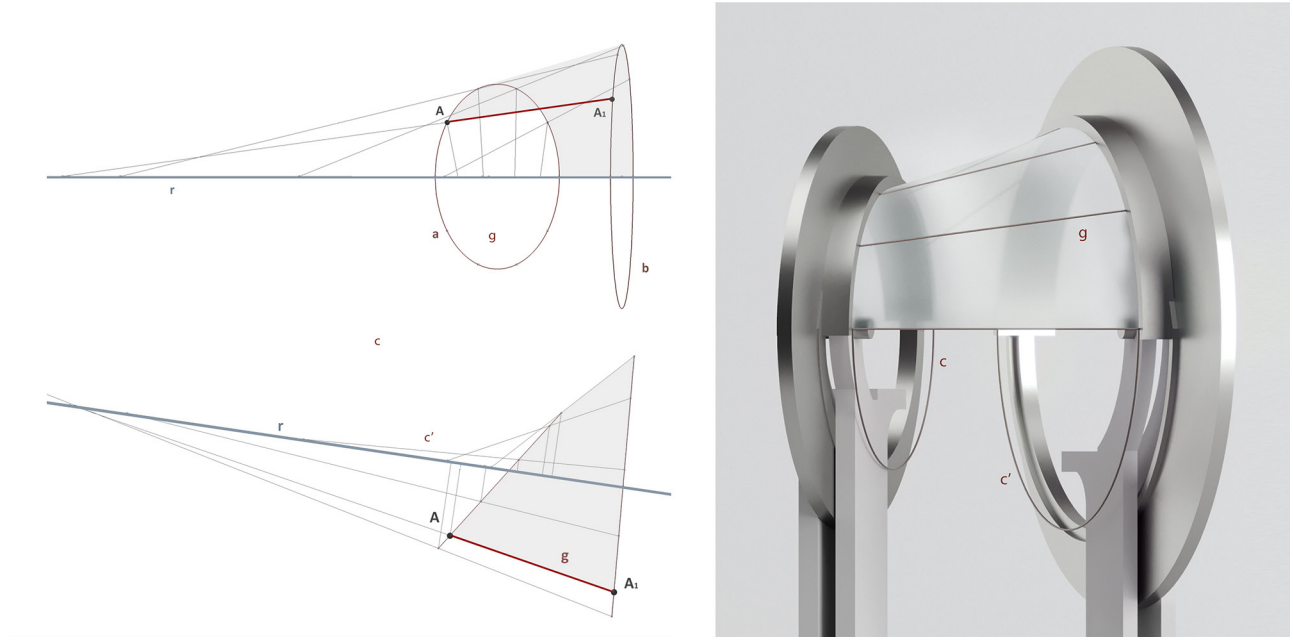


Fig. 12. Genesis of the cape as a cylindroid.



"Maybe the country does not move", Renato Pedio comments in the pages of *L'architettura, cronache e storia* regarding the Osaka pavilion [Pedio 1969, p. 55]. Notwithstanding the transitory nature of the Expo and the technological capabilities of the host country, the project did not continue. Thus, nothing remains of the cape except for the drawings which, even today, communicate the force of an idea.

The authors shared the contents and the critical analyzes conducted in this study. In particular, Marta Salvatore dealt with the coordination and the methodology, Lorena Greco the historical aspects, the experimentation on the ruled surfaces and the digital images elaboration, Maria Laura Rossi the experimentation on the cyclids.

Notes

[1] The control of the geometrical properties of the form in this study was conducted through the NURBS mathematic which, as is known, describes lines and surfaces in space, in a continuous way, through mathematical equations of a parametric type.

[2] See: Sacripanti, M. Progetto per il nuovo Teatro lirico, Cagliari. In Neri, Thermes 1998, p. 60.

[3] "At the last biennial a Cage ballet was represented with scenes and costumes by Rauschenberg. I remember well the stimulating show and the unappealing scenography accompanied my memory. The Cagliari competition was an occasion to overcome old disappointments […]": Neri, Thermes 1998, p. 60.

[4] This way, Sacripanti describes the idea at the basis of the cape in the technical report of the project: Sacripanti, M. Progetto per il padiglione italiano alla Esposizione Internazionale - Expo 70, Osaka (Giappone). In Neri, Thermes 1998, p. 117.

[5] Sacripanti, together with Eng. Maurizio Decina, thought up a computerized programming of movement. They designed a compressed air pneumatic mechanism for the propulsion and automatic control of moving structures. These structures are activated through programmed movements, according to pre-established temporal sequences, recorded in code on perforated tapes, decoded by a special reader. Sacripanti used a technique, as Decina recounts in his *Testimony* available through the Fondo Sacripanti at Accademia di San Luca Archive, by which he was particularly fascinated. The functioning of the mechanism is amply described in the design report: Sacripanti, M. Progetto per il padiglione italiano alla Esposizione Internazionale - Expo 70, Osaka (Giappone). In Neri, Thermes 1998, pp. 118-120.

[6] In the motion each of the blades would follow an own oscillation. This independence would have differentiated the dynamic movement of architecture from the repetitive and serial characteristic of mechanical components, such as pistons or connecting rods, from which this explicitly took the distances: Sacripanti 1973, p. 90.

[7] The technical report does not have specific information about the shape and size of the wings: the same indication concerning their arrangement is ambiguous, since the motion plans are different for each blade: Sacripanti, M. Progetto per il padiglione italiano alla Esposizione Internazionale - Expo 70, Osaka (Giappone). In Neri, Thermes 1998, p. 115.

[8] Achille Perilli collaborated on the Osaka project. It is possible that Sacripanti referred to him in the design report, although Perilli declares that he had worked only a little on the project, because of the many changes made in his design process. See the interview with Achille Perilli in *Testimonianze*, Accademia di San Luca Archive, Fondo Sacripanti. <http://www.fondosacripanti.org/testimonianze.php> (accessed 2018, March 21).

[9] See the interview with Franco Purini in *Testimonianze*, Accademia di San Luca Archive, Fondo Sacripanti. <http://www.fondosacripanti.org/testimonianze.php>(accessed 2018, March 21).

[10] See the interview with Achille Perilli in *Testimonianze*, Accademia di San Luca Archive, Fondo Sacripanti. <http://www.fondosacripanti.org/testimonianze.php> (accessed 2018, March 21).

[11] See the project report in: Sacripanti, M., Progetto per il padiglione italiano alla Esposizione Internazionale - Expo 70, Osaka (Giappone). In Neri, Thermes 1998, p. 117.

[12] Dupin's cyclide owes its name to Charles Dupin, a pupil of Gaspard Monge who, in the second half of the nineteenth century, first defined the properties of this surface.

[13] The curvature lines cover the surface without gaps, forming two series of curves orthogonal to each other, which indicate, in each point, the direction of the main curvatures of the surface.

[14] It is possible to construct a Dupin's cyclid in the digital space by enveloping its curvature lines. The greater the number of lines of curvature lines, the better the approximation.

[15] A minimal surface disposed between two skew disks would assume the form of a soap foil, obtained by imagining immersion of the structure of the blades in a soapy solution.

[16] See the interview with Sacripanti titled *Maurizio Sacripanti | "Più di questo non so dirvi …",* 1989, by Luca Ciancarelli and Gaia Remiddi, in "Interviste", Department of History, Representation and Restoration of Architecture (ArchiDiAP), Sapienza University of Rome website: <http://www.archidiap.com/intervista/piu-di-questo-non-so-dirvi-maurizio-sacripanti/> (accessed 2018, March 21).

[17] Renato Pedio recounts that Sacripanti would have modified the symmetry of the pavilion if the project had gone ahead: Pedio R. Per Maurizio Sacripanti. In Giancotti et al. 1997, p. 22.

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Territories and Frontiers of Teaching

Interpret the many variable dimensions of the identity of teaching in the field of survey and representation using case studies highlighting the reciprocal relationship that can occur between teaching and research.

Now it's up to the Architects Return to Drawing

Nicola di Battista

If it is true, as we said to write two year ago in the editorial in the magazine *Domus*, that we are at the beginning of a new season, then what is most important for us to understand is how to approach and how to take part in that season, what role we want to play in it and above all whether we want to determine it, even only partly, or be subjected to it. This thinking concerns us from at least two points of view: one that concerns every one of us as individuals, and the other collectively, due to the craft, the profession that we practise as part of a community.
Let us start then from this second point of view, the one that sees us as part of a collectivity determined by our work and by the surroundings and issues stemming from it. We are talking here about the architect's job, a job that can be done only by those regularly enrolled in this association, a job regulated by a set of civilised rules and professional ethics to be respected. We are talking therefore simply about a job, one of the many done by men and women.
If we turn now to the architect's craft as a whole and its place in time, we realise what an incredible past our country has had. The past has witnessed its pre-eminence in diverse periods of history and made it renowned worldwide for baving defined a certain idea of Italianity in the art of living. Even this consideration alone shows just how

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mistaken and misleading it is to reduce the architect's craft merely to its statute of work. It is certainly a job, but definitely not just that, since habitation is about human beings and their entire lives.
To come back to the present, whether or not because of this inherited fame and splendid past, the fact is that we have been looked upon, for a long time and up until now, as the land of architecture, of fine and beautiful architecture. This situation has allowed us for a long time to hold the world's undisputed record in number of architects. Almost all of these architects study and graduate in our own universities –all of them public– and are later enrolled in the respective professional associations of their home cities. The numbers rotating around the training of architects in Italy are stunning. If we include its allied activities, we are talking about hundreds of thousands of people – something very relevant that calls for thorough attention and reflection. When you come to think of it however, con sidering all this and the large numbers of people rotating around architecture, not only is there no lively and frank debate to animate the discipline today, as ought to be expected, but there is not even an authoritativeness of our excellence to match our numbers, and ultimately not even a big enough turnover to justify all this. Our architecture schools, with the means at their disposal, are managing to day to deliver an averagely good training, even compared to what happens in the rest of the world. But we should start by answering the question: 'good' compared to what? To do that however, we need first to answer another question: What task should be performed by a school and by a state-run school in particular, in the training of a future architect? That of teaching a craft, training the future professional, making excellence possible? None of these tasks is actually carried out by our architectural training facilities, but then why should they be anyway? After all, these are certainly not the duties of a school. A craft, of course, is not learnt at school, but as we well know, only by practising it. And that goes for professional training too, which requires highly specialised studies and skills. Finally, the forming of excellence requires some very sophisticated and appropriate teaching structures. So what sort of training do Italian schools offer their students? Wanting to link them to a common goal, we can say that they do impart a university-level, hence generally higher form of education. It is a kind of education aimed chiefly to augment the students' cognitive relation lo their discipline, so that once they have finished their studies, they can properly tackle and solve the problems to be faced in their future work. In the last analysis, this means that our schools of architecture should primarily be concerned with the *forma mentis* of their students, in the awareness that the true architect is nota technician, nota specialist. On the contrary, he is a person with the capacity to pick the right technician or the most competent specialist to help him best fulfill his work. The true architect is a person who, by nurturing the ambition to imagine, design and some times to realise the places where people live, undertakes to assemble the specifications proposed by a client, community, or even simply those expressed in general by the human spirit of their time, in order to elaborate, summarise and transfigure them into architectural forms, into buildings. Clearly, a school therefore cannot and must not be the only form of higher education available to an architect, who will learn his trade only with time and in certain conditions. A person does not become an architect because he has passed a certain number of exams at a school. The vast mass of architects graduating from schools is formally an architect in a so much as each possesses a '*diploma*' to that effect. But if they have no context, time or condition to become one in effect, they never will be real architects. Among the innumerable architects in this country, there are certainly some very good ones, and certainly some excellent professionals. Conversely, there are only a few specialists, and above all very few real architects, in the sense outlined above. This implies that the true architect is not only the product of an architecture school, but also of a context, a place, a community that expresses and supports that architect.
If we have few real architects in our Country today, it means simply that in recent years we have failed to produce them and have been concerned with other matters. On looking at our surroundings today, we realise how short-sighted and senseless that choice has been, and how much damage it has done to civilised habitation, having transformed what was once the '*Bel Paese*' into what is now quite an ugly Country.
We have so far talked about architects generally, by referring to all of those practising this profession, and to the schools that train them. But we ought now to start thinking about the individual person, the individual architect. As an individual, everyone is responsible for what they do or do not do, and even if there are always excellent reasons for doing or not doing a certain thing, we cannot afterwards feel exempt from any obligation to judge

what has been done. From this point of view, we cannot say today that in the past years we have done everything possible to make things change. For a long time too many of us have remained uninterested in the outcome of the work itself, treating it as a fact, without judging it, without understanding its qualities and failings, without understanding whether or not it had attained its goal. The result of this work has no longer been, for too long and for too many architects, the touchstone by which to judge one's own and other people's capacities. In this way, the architect's work has lost authoritativeness, and the architects themselves have no longer thought of it as something to be proud of. And so they have strayed farther and farther from their objectives: to succeed by their efforts in giving people better lives. We have thus lost the capacity to recognise the quality of a work and the extraordinary gifts that it may possess and transmit to us when it is genuine and innovative; we no longer recognise how its unexpected and surprising results can arouse wonder. We have ceased to judge our work as architects for what it produces and achieves, or even for what it prefigures through its design. In a word, we have too often avoided the issue and been content, perhaps in good faith, even with partial or lesser results, which may perhaps bave seemed shortly rewarding and left our consciences clear. But in reality, they did not advance our discipline by as much as a single inch.

But all this by now can be left behind, overtaken by events and already part of the past. It will very soon all be forgotten. Our times consideres recent past to have run its out of, and above all as no longer credible. Instead, they offer increasing for a collective sentiment that is gradually growing stronger and loudly demanding a renewal. Our times by now demand something else, which is why it is up to architects to intervene. And that applies to those who are already real architects, but also to those who could or would like to be. Young and not so young, there is a big need for all, and now is the time. We know that it is by now indispensable to imagine and to create new lifestyles for contemporary humankind, better fitted to out times and our means. So-caJled civilised society is beginning to realise this, and its better part is talking about it openly. Likewise, there is an equaJJy strong awareness on the part of many cities, even outlying or minor ones, and of their administrators, that a rebirth is necessary and at last possible, starting precisely from the cities themselves as a common asset. In the face of this reborn awareness of what needs to be done to renew the designing and governance of our houses and neighbourhoods, cities and land, all the places of our private and public life, architects still seem to be missing, continuing to apply old and obsolete methods in their work. They are not listening, and above all, they are failing to give form to the new demands and needs, to the new requests and to the new dreams of our times. If until a short while ago architects could, and rightly, complain of the lack of a context or of the absence of a question to be answered with their own efforts, today there are all the symptoms of a striking change. Of course, it takes determination, patience and time to seek them, because they are not yet solid and consolidated, but they are already undoubtedly and irreversibly there. For this reason, it is up to architects now to seize this new situation and turn it into forms to fit it, forms that can be shared and convincing. And they must do so before others appropriate the same terms in favour of yet another ideology or '-ism', after which it will be too late. Then it will only remain to complain, once again, that our craft has been stolen by other professions or disciplines. Architects should go back to being architects, innovating while prioritising humanity over clients. Let them seek in the spirit of their times what to place at the base of their work as the content that will support it, as they push and strive, perhaps take on risks and venture even without a safety net into territories they might not be so familiar with. Now is the time for architects to act, to renew the role that they bave had at other times and that they could regain. A role that bases its structures in a discipline that can be considered, in full measure, the mother of all the disciplines that revolve around the architecture or the drawing. It is useful then to ask a question: what is the role ofthe architect's representative not as a disciplinary expert but to direct the work of architects, and the reflection on contemporary architecture? Specifically, what kind of contribution provides the Architecture Drawing for Contemporary Architecture? In synthetic terms: what relationship exists between drawing and design? A reassuring answer can from the dual nature of the drawing of Architecture, which, as demonstrated by the Renaissance to our contemporaneity, is manifested both as a knowledge through prominent design and as being viable through drawing. Returning to the beginning of this text, we firmly believe that a new season cannot depart from this ability to read the past in order to hypothesize of life, and therefore of the future, more suited to the needs of man in the complexity of society Contemporary. Looking at drawing of Architecture as a discipline

that can provide the architect with awareness of the past and hope for the future work hypothesis and at the same time necessary to educate younger generations, specifically Architecture students, to a renewed Sensibility for heritage inherited from the past and its subsequent enhancement. An enhancement that improves not only the architecture and the city but also the life of man that, within them, should be conducted in a newfound harmony collective dimension.

Notes

[1] *Domus:* <https://www.domusweb.it/it/editorial/2015/10/12/ora_tocca_agli_architetti.html>(accessed 2018, march 21).

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Virtual Immersive Models for Viewing Social Science Fiction in European Cinema

Federico O. Oppedisano, Daniele Rossi

Abstract

The paper illustrates the scientific assumptions and the results of a didactic activity aimed to explore the potential of interactive and immersive dynamic perspectives by experimenting with new virtual reality applications for the enhancement of cultural heritage. In particular the study focuses on the enhancement of some European sociological science fiction movies. In this sense, immersive virtual reality, experimentally, has been used to realize and explore models capable of representing the quality of the space and emotional conditions present in the selected movies.

Keywords: Interactive Walkthrough, 3D model, Sci-Fi movies.

Virtual reality as an "immersive" culture

Stimulated by the film and video game industry, contemporary visual culture has been enriched in recent years with new technological opportunities capable of expanding spectators'/observers' perceptual experience. The computerized three-dimensional image, with its goal of representing space precisely and reliably, generates an illusion of virtual space perceived so completely that it is experienced in a state of total cognitive immersion. What changes, therefore, is the way of viewing things: a static vision strongly conditioned by the canons of perspective has yielded to a continuous, changeable view that simultaneously makes users participants in everything that develops within the scene. The cognitive conditions change but above all the spaces of investigation and the potential of the interactive and immersive dynamic perspective change [Migliari 2009]. These potentialities, immediately intuited and presided by the video-gaming industry, now open themselves to different research fields, prefiguring different scenarios able to broaden their application horizons.
In this framework, a didactic research was started to verify new applicative declinations of immersive virtual reality to stimulate and give attention towards cultural dimensions that are alternative to the recreational ones. The aim of the experimentation was to promote, through immersive virtual reality, a cultural reality identified among those closest to the virtual dimension, namely cinematography. Indeed, the cinematography, imposing

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itself through dynamic figurative levels, is able to determine, as Roland Barthes states, imaginaries in which the spectator identifies 'narcissistically'. Regarding the cinematographic image, Barthes affirms: "he catches me, he kidnaps me: I glue myself to the representation, and it is this glue to found the naturalness (the pseudo-nature) of the scene filmed […] the Real, for his part, knows only distances, the Symbolic masks; only the image (the Imaginary) is 'close', only the image is 'true' [Barthes 1994, p. 148].
Among the film genres, science fiction has been singled out to reinforce the proximity between cultural dimension and immersive scenery. It is directly linked to virtual reality, since science fiction is above all, as Lino Aldani states: "a form of representation that establishes, through the exceptionality of the situation, a different relationship with things" [Aldani 1962, p. 17]. Among the sub-genres of science fiction, the so-called sociological science fiction developed around the 60s, especially in Europe, is that which presents aspects of particular cultural importance, because it offers the possibility not only to hypothesize the shape of the future but also to reflect on the condition of present.

Social science fiction as a cultural paradigm

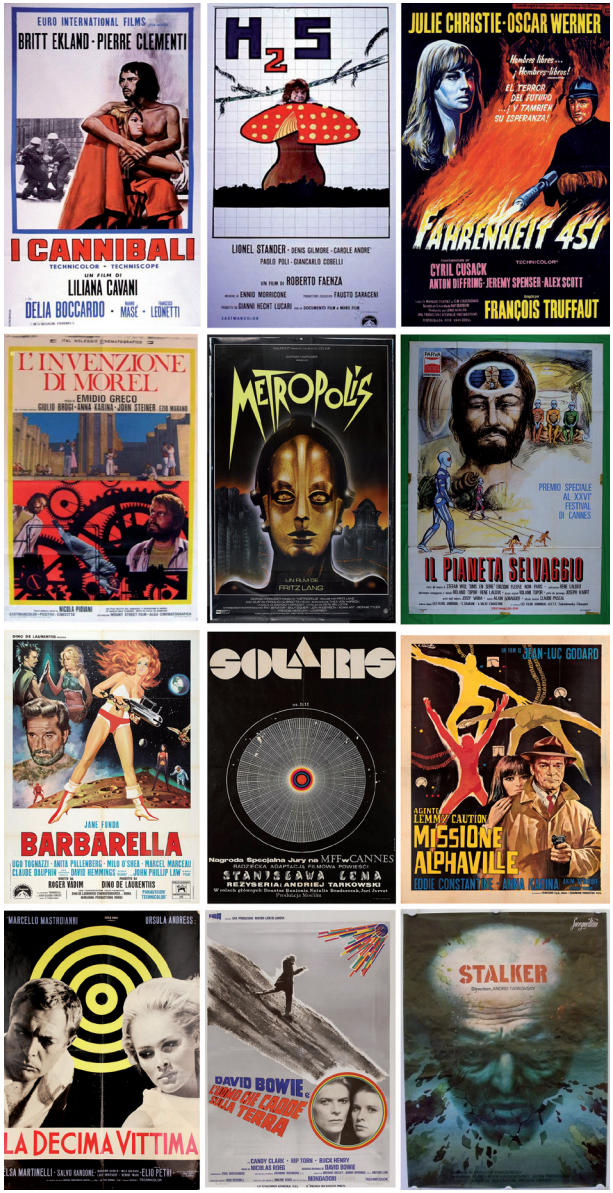
Social science fiction is largely related to science-fiction literature, which in turn grew out of utopian narratives–in large part *voyages extraordinaires*–but also the writings of Plato, Lucian of Samosata, Thomas More, Cyrano de Bergerac, and Jonathan Swift [Suvin 1985, p. 488]. Despite this, there are rare cases in which literary criticism has conferred on science-fiction novels the dignity of a work of art, both because its popular roots go back to Gothic fiction and because its spread was promoted through low-cost magazines and printing on low-quality paper [1]. The two main examples relating to scientific progress can be found in the fantasy novels of Jules Verne and H. G. Wells. The former enthusiastically gathers the possibilities of progress and introduces the scientific factor as an assumption in the fantasy and adventure narrative to make the stories more plausible [2]. Wells, on the other hand, concentrates on the theme of injustice and social inequality, proposing distorted future scenarios. In some way, the spirit of his stories reflects fears related to progress, which would be transformed into reality with the First World War, marking an end to the optimistic vision of science that had characterized the nineteenth century in Europe.
If the narrative overseas is characterized as escapist literature, the European narrative appears to adhere to the anti-utopian vein followed by Wells. The themes of the stories revolve around individual and societal problems. The narratives do not concentrate on the battle between good and evil or the description of intergalactic wars, but on the problems that progress meant for society and the individual such as pollution and overpopulation [3]. Science fiction, therefore, becomes a metaphor for life and a way of denouncing deep contradictions and social alienation [4].
The genre began to develop around the 1960s and so-called social science fiction, which, influenced by the radical changes in customs and society, proposed stories that set the technological aspect as the narrative backdrop to concentrate on investigating 'inner space' [5]. The unconscious became the terrain to experiment with new narrative models such as the characters' internal monologues, which are well suited to recounting the mental imbalances of humans in society [6]. This new dimension of science fiction in film interested various filmmakers who were not specialized in the genre, but rather used the metaphor of science fiction to denounce possible societal trends and made full-length films largely inspired by literature whose content in the cinematographic panorama of the era was innovative and particularly important. French New Wave is one example. Influential films include *Alphaville* (1965) by Jean-Luc Godard [7], *La Jetée* (1962) by Chris Marker, and *Fahrenheit 451* (1966) by François Truffaut. Other notable films include *Barbarella* (1968) by Roger Vadim, *Solaris* (1972) and *Stalker* (1979) by Andrej Tarkovskij, and *The Man Who Fell to Earth* (1976) by Nicolas Roeg, as well as animated films such as *La planète sauvage* (1973) by René Laloux.
In Italy, the social aspect of science-fiction films seemed to be a more of an underground phenomenon. It includes, in many cases, little-known works such as *Omicron* (1963) by Ugo Gregoretti, *The 10th Victim* (1965) by Elio Petri, *H2S* (1968) by Roberto Faenza, *Colpo di stato* (1968) by Luciano Salce, *The Tunnel Under the World* (1969) by Luigi Cozzi, *I Cannibali* (1970) by Liliana Cavani, *N.P. Il Segreto* (1971) by Silvano Agosti, *L'Invenzione di Morel* (1974) by Emidio Greco, *I Viaggiatori della Sera*

(1979) by Ugo Tognazzi, and *Il Seme dell'Uomo* (1969) by Marco Ferreri.
Despite being vastly different, these art films were created through experimentation. They are denoted as science fiction certainly not for their scenography, but rather for the assumptions inherent in the narrative. Due to the weakness of the production means, they present particularly original linguistic connotations in the panorama of the cinematographic culture of the time.

Experimentation. *Inside Sci-Fi*

A social science-fiction film [9] was assigned to each student [8] (fig. 1) and it was taken from a list created by the teachers. The goal was to study and develop a three-dimensional digital model that could be explored immersively. The model had to be capable of evoking the sense and most important meanings that characterize the feature film, representing the visual tone, atmosphere, and colours without yielding to hyper-realistic or imitative inclinations, which would lead to the simple realization of scenographic models.
The science fiction cinema thus becomes a cultural paradigm that can find immersive virtual reality in new forms of divulgation and knowledge in a new visual dimension. Virtual reality is able to make the atmospheres and the tone that characterize the works of this kind 'tangible', using the science-fiction metaphor, in order to urge the public to reflect on reality.
Based on these assumptions, the 3D models created by the students aimed to overcome the purely expository limits of immersive reality and the simple exploration of artificial spaces. Rather, they were designed as experimental formulas capable of stimulating users to discover the content of cinematographic works. Therefore, manneristic scenographic reconstructions were avoided. Instead a path was constructed in which users are invited to retrace and connect the elements of the work redesigned in graphical and auditory forms. These spaces condition the observer's view, which is fragmented into an infinite number of possible viewpoints, thereby contributing to the definition of a logistical dimension of the image. Walking, guiding, and looking are actions that always imply spatial measurements.
In this operational framework, the interactive and immersive dynamic perspective drew on the visual con-

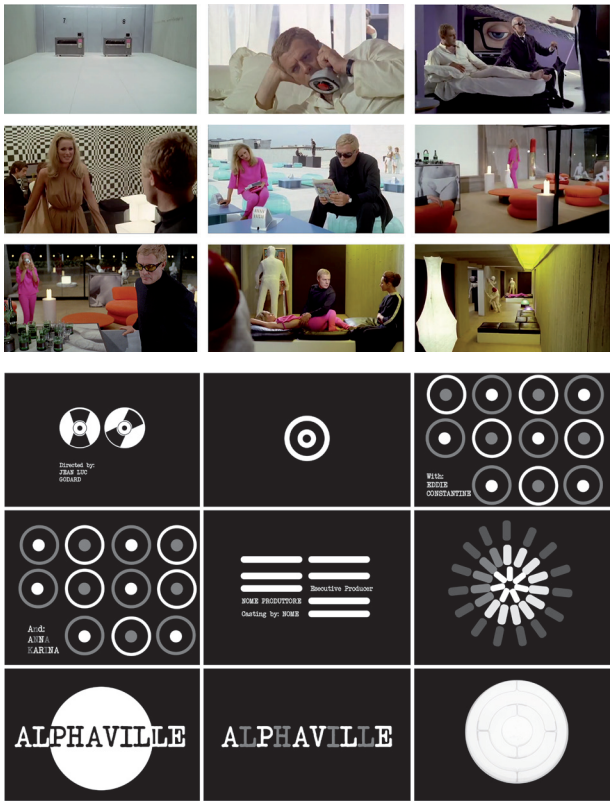
Fig. 1. Posters of the movies for which an immersive virtual model has been created.



sciousness of video games, a three-dimensional representative/exploratory mode by which and in which 'another' perception of space-time is reached wherein each element seems to be fluidly connected to all the others. This evolution modifies both our conceptual baggage and the experiments in application deriving from it. Our tendency towards abstraction is increased, as is the possibility of managing a new complexity linked to interaction and movement.
Each student therefore designed and developed a virtual environment in the form of a navigable 3D model based on a careful preliminary study of the director's style, the characteristics of the work and the historical moment when it was made. Each film was deconstructed to define the spatial areas and analyze the graphical apparatus.
These preliminary reflections were concretized in a series of summary graphical works such as: key frames, colour palettes, scenic objects, or artistic references. The key frames were collected on a moodboard containing visual fragments and graphical suggestions from the film. The colour palette was used to analyze the graphical spectrum and infer the chromatic code to use for the backgrounds, materials, and textures in the 3D model. Finally, the selection of props or artistic references allowed some strongly suggestive iconic objects present in the film to be included in the model (fig. 2). Indeed, as mentioned above, since they are characterized by a social connotation that does not glamorize visual effects, the selected films required some graphical references that were easily recognizable and capable, for example, of recalling a determined historical period [10].
Once the first step in graphical analysis was complete, the design and 3D modelling of the settings was addressed. Modelling techniques for real-time rendering were used, thereby favouring the use of graphical textures to add micro-geometrical data rather than weighing down the model with unnecessary polygons. Following this, the virtual environment to be explored with the interactive and immersive dynamic perspective was prepared. To this end, a hardware/software system composed of the graphical engine Unreal Engine [11] and the Oculus Rift [12] virtual-reality head mounted display was used. In this phase, the number of polygons in the 3D model was further optimized to lighten the model and guarantee fluid navigation greater than 60 fps. The setup of the scene was then finalized by adding an illumination system deriving from the preliminary analysis and prefigured in some initial concept arts (fig. 3) and using particulate systems and visual effects to simulate the atmosphere.
These environments were then validated and experimented with using the HMD device for virtual-reality vision with the Oculus Rift. The representative and narrative qualities were verified and the degree of immersion in relation to the scale of representation was measured.

Fig. 2. Board containing props and artistic references regarding La Decima Vittima (1965) by Elio Petri (student: Nicola Brucoli).

Fig. 3. Graphical element for the immersive 3D model of Alphaville (1965) by Jean-Luc Godard (student: Livia Barone).



Project methodology: the immersive virtual environment of Andrej Tarkovskij's *Stalker* film

In order to clarify the methodological process followed for the configuration of immersive virtual environments related to selected cinematographic works, we report in this section the case study related to the film *Stalker*, directed in 1979 by Andrej A. Tarkovskij. This analysis is suitable, for poetics and contents, to describe and exemplify some of the analytical and generative processes mentioned above and to briefly illustrate the methodologies adopted in relation to the designed and prototyped artefacts.
Preliminarily, we conducted a study aimed at framing the historical-cultural context in which the movie was shot, placing it within the artistic research of the director. Synthetically, the figure of Andrej A. Tarkovskij director, screenwriter, editor and film critic, moves within different genres, proposing to the viewer his ascetic and personal vision of the world. Among his movies, recognized as masterpieces, in addition to *Stalker* we also remember another sci-fi movie: *Solaris* [13], and *The Mirror*. In these movies the director places in the foreground the profound search for the inner world of man. For Tarkovsky it is important to make a journey into psychology, the philosophy that nourishes mankind: "within the literary and cultural traditions on which his spiritual foundations rest" [Tarkovskij 1988, p. 181]. The science fiction for Tarkovsky is a pretext, it represents only the starting situation, which it helps him to "define in a more plastic and sensible way the moral conflict" [Tarkovskji 1988, p. 178] fundamental in the movie.
Stalker is based on the novel *Roadside Pic-nic* written by Boris and Arkadij Strugackij [14]. It tells about an expedition towards a post-industrial landscape in search of a mysterious Zone carried out by a writer in search of inspiration and a professor in search of scientific discovery, and led by a figure known as the *Stalker*. This figure, says the director, is apparently weak, but in reality "invincible because of his faith and his willingness to serve men" [Tarkovskij 1988, p. 166].
In the Zone there is a room in which the most intimate desires of people can be realized, a place in which the life of individuals can be radically changed [Bordwell, Thompson 1998, p. 443]. The area is a no man's land "a place where the norm, the rule that the border establishes is no longer worth, the wild land where everyone has to look after himself and everything becomes possible" [Zanini 1997, p. 15]. In this sense, for Tarkovskij, the Zone "does not symbolize anything: the Zone is the Zone, the Zone is the life: crossing it or breaking it, or resisting. If man resists it depends on his feeling of his dignity, on his ability to distinguish the fundamental from the passenger" [Tarkovskij 1988, p. 178].
Tarkovskij writes: "In *Stalker* I express my thoughts to the end: human love is the miracle that can be opposed to any arid theorization that there is no hope in the world. […] In this film I wanted to emphasize that specifically human element, which can not be dissolved and decomposed, which crystallizes in everyone's soul and constitutes its value" [Tarkovskij 1988, pp. 177-178].
The Russian musician Eduard N. Artemyev has edited the soundtrack, writing tracks that combine electronic sounds coming from a synthesizer with those of musical instruments typical of the Middle-Eastern area. In Tarkovskij's work the soundtrack has always played a fundamental role: for the director in fact "Music can be used to produce a necessary distortion of the visual material in the audience's perception, to make it heavier or lighter, more transparent, subtler, or, on the contrary, coarser. By using music, it is possible for the director to prompt the emotions of the audience in a particular direction, by widening the range of their perception of the visual image. […] Perception is deepened" [Tarkovskij 1988, p. 145].
This first phase, dedicated to the historical-cultural analysis of the movie, proved to be of fundamental importance for defining the parameters of representation of virtual environments. Subsequently, some specific analyzes of the most significant scenes of the film were conducted in order to understand the visual tone of the movie in both color and perceptive terms. From this analysis we have elaborated, on the one hand, a color palette (fig. 5) to reveal the chromatisms of dark atmospheres consisting largely of cold colors, with a dominant color that moves gradually from gray to gradations of blu and yellow; on the other hand, a moodboard was created (fig. 4) in which frames were taken with shots that use medium fields to show the external spaces and the Zone, as

Fig. 4. Moodboard regarding the movie Stalker (1979) by Andrej Tarkovskij (student: Nunzio Liso).

Fig. 5. Color palette from Stalker (1979) by Andrej Tarkovskij (student: Nunzio Liso).

well as close-ups showing the expressions of the protagonists and some of the symbolic elements in the author's poetics such as water, fire, fog, light. Similarly, the analysis of the sound landscape has allowed us to identify and sample three types of diegetic and extradiegetic sounds: those relating to the soundtrack, those relating to ambient noise, and finally the human voices of the actors.

This set of elements made up of sounds, colors and symbolic elements have become the main parameters through which to set up the construction of the immersive audiovisual experience of the virtual environment.

These analyzes have guided the definition of a spatial and emotional path in which three-dimensional geometric components, synesthetically, must be accompanied by a sequence of emotional states capable of leading the visitor into a slow wander able to evoke the sense of 'journey' of the three protagonists of the movie seeking the Zone.

The designed walkthrough, together with some other artworks (concept-art and storyboard) (figs. 6, 7) allowed to define the gameplay (fig. 8) of the immersive 3D model. In the design of a video game the gameplay represents the set of spatial and interactive conditions that influence the gaming experience of the single user. The artwork shows all the places can be visited and the systems of interaction with them. Interfaces and triggers are dislocated on a schematic representation of the model, in order to validate the possibilities of 'playing' and the appropriateness of the displacements in relation to the possible interactions. Three main places, corresponding to the levels of consciousness of the three protagonists, are organized around two distribution corridors that intersect at the land point (the spot where the user starts the immersive experience).

Within these environments, three triggers and six video outputs complete the exploration experience allowing the visitor to immerse themselves in the last environment, an unlimited space in which to let oneself fall, relaxing, releasing the accumulated emotional tension and participating in the drafting of the emotional narration necessary to make the final experience strategic and convincing.

Technically, once the gaming experience has been outlined, the use of polygonal modeling systems

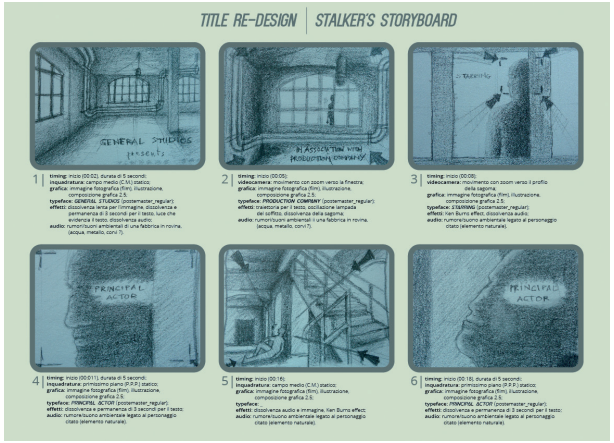


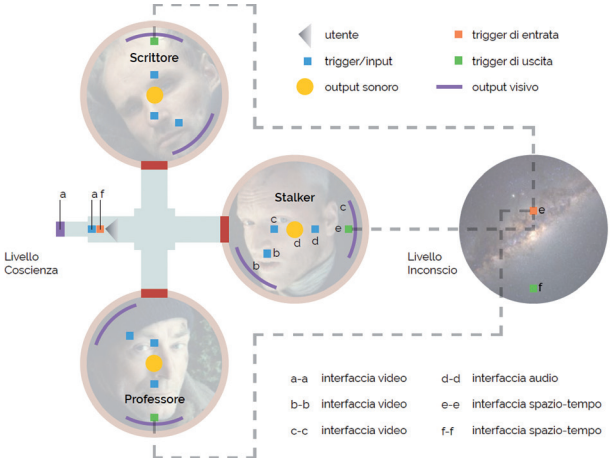
Fig. 6. Storyboard regarding the immersive 3D model of Stalker (1979) by Andrej Tarkovskij (student: Nunzio Liso).

Fig. 7. Concept-art regarding the immersive 3D model of Stalker (1979) by Andrej Tarkovskij (student: Nunzio Liso).

(*Modo*) has allowed the construction of three-dimensional models optimized to be rendered in real time on the graphic engine chosen for this experimentation (*Unreal Engine*) (fig. 9).
The texturing phase, based on the previously analyzed color sampling, has finally completed the construction of the 3D model adding micro-geometries and noise that contribute to 'stain' the polygonal mesh, dramatically increasing the spectral and narrow tone. Following these specifications, the distribution corridors were designed as if they were underground tunnels with a circular section, while the three environments were designed as three circular-shaped rooms occupied only by a well in the middle and by some wall-mounted screens. Once activated, these screens show in loop some scenes of the movie. The fourth environment, which the visitor can visit after approaching one of the wall screens, consists of a textured sphere with an image of the deep space so as not to be able to grasp the actual dimensions and in which one falls without the possibility of control. A delay triggers concludes the experience by returning the user to the initial landing point. Light sources with low emissive power and volumetric fog positioned inside the three macro-environments complete the visual set-up of the scene, contributing substantially to amplify the perceived degree of immersion. As for the sound apparatus, it is composed of a series of omnidirectional emitters inside the tunnels propagating white sounds, simulating the noise of the rain or the human steps on the floor. In the three rooms instead, music and dialogues sampled directly from the film are combined with movies projected on wall screens. Finally, in the last room, the continuous fall of the user is accompanied by a binaural audio track that acts as a further relaxing element.
The final result is an immersive experience in which three descriptive planes intersect and integrate each other. On the visual level, the photorealism of the model thus designed illudes the visitor to find himself in a real space, while the artificial lighting system and the volumetric fog signal the directions of movement in a non-invasive way. On an acoustic level, white noises and sound effects inhabit the same geometric space, guiding the user from a psycho-physical state characterized by anxiety to one characterized by relaxation. On the interactivity level, finally, triggers and video outputs, strategically placed, force the user to interact with the 3D model according to a role mechanism triggered by the curiosity to move within the Zone (fig. 10).

Fig. 8. Gameplay planning (student: Nunzio Liso).

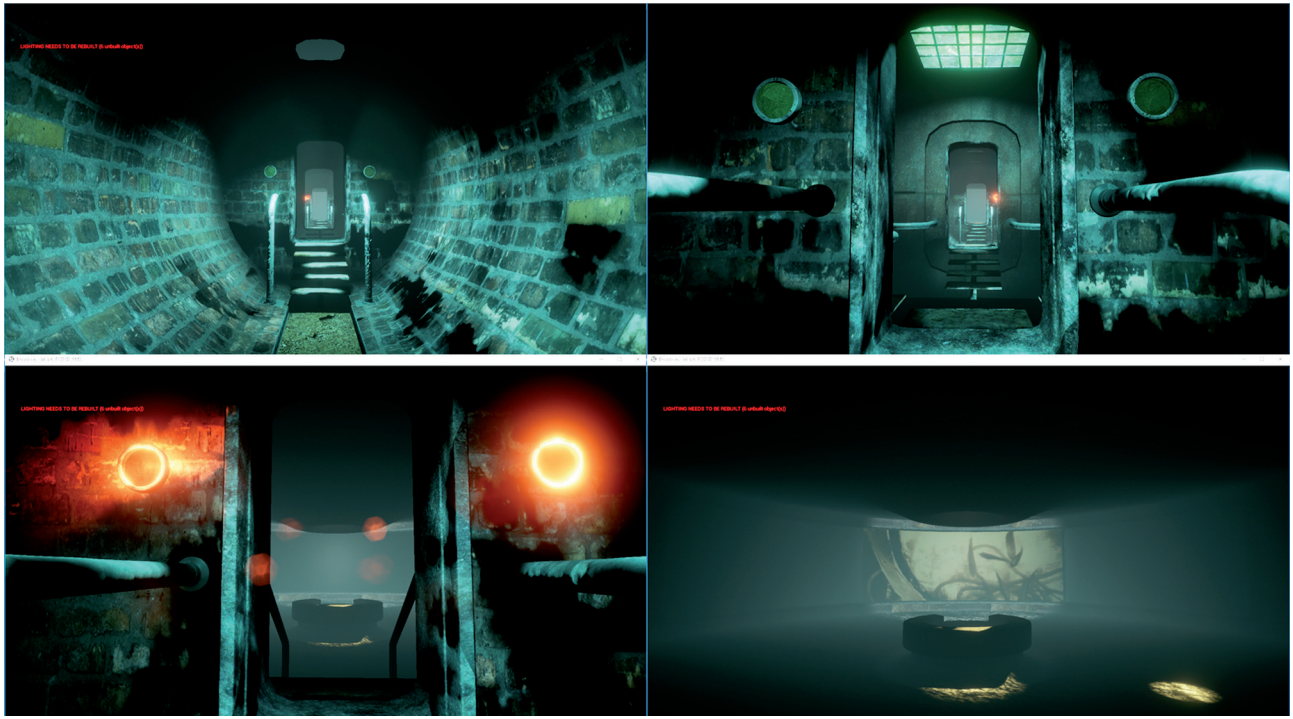
Fig. 9. The scenic layout of the 3D model in the graphic engine used for experimentation (Unreal Engine).



Conclusions. The potential of interactive and immersive dynamic perspective

The main objective of this activity was to experiment with new applications of immersive virtual reality and to understand how this could become an instrument of knowledge and dissemination of cultural contents, combining it with another reality of 'immersive' nature such as cinematography, and evaluating at the same time the expressive and revealing potentialities of the interactive dynamic perspective. Therefore, the immersive virtual reality was intended as a tool able to represent spaces and models with a strong emotional charge able to enhance the set of spatial and emotional conditions that characterize the visual tone (atmospheres, perceptions, symbols, objects and so on) of an almost unknow filmography, but nevertheless representative of some particular historical moments of our society.
The direct comparison with the language of cinema also allows us to reflect on the ways in which the environments so constructed can be narrated. Film grammar allows us to define an analogy between the dynamic interactive perspective and a film shooting technique that has become a pervasive stylistic figure in the new media: first person shot. Ruggero Eugeni defines it as a symbolic form and more precisely: "a ubiquitous and almost omnipresent figure within the intermediate and post-cinematic galaxy that characterizes contemporaneity" (Eugeni 2015, p. 53). First person shot hybridizes with areas and experiences arising from the world of video games in the first person and becomes a symbol of a visual culture characterized by perceptual habits dominated by first-person experiences.
Space can be used as if one were really within it, moving virtually through the 3D scene visualized, approaching, moving away from, or changing our direction of view, that is, using a system to simulate possible movements in space via a naturally intuitive interface. The interactive and immersive dynamic perspective holds enormous potential regarding the means of describing and discovering 3D environments. The possibility of first-person exploration improves the geometrical perception of three-dimensional models. Stereoscopic visualization using immersive virtual-reality visors, combined with the possibility of moving freely with one's own viewpoint improves the capacity to understand the spatial quality of places in which one is immersed.

Fig. 10. Some frames of the interactive dynamic perspective taken from the immersive 3D model developed for the film Stalker (1979) by Andrej Tarkovskij (student: Nunzio Liso).



Notes

[1] Hugo Gernsback founded the magazine *Amazing Stories* in the United States in 1926, which made the fantasy genre a popular phenomenon. In 1929 he founded *Science Wonder Stories* and coined the term science fiction instead of the previous term scientifiction.

[2] Verne claimed that Wells' novels lacked any plausible scientific basis.

[3] These topics were developed by Anthony Boucher, director of *The Magazine of Fantasy and Science Fiction* and Horace Gold, director of *Galaxy*. For further information cf. Asimov 1984.

[4] One of the most important authors in this period was Ray Bradbury.

[5] As defined by the writer J. G. Ballard. In this period, the magazine *New Worlds* was born in England and directed by the English writer Michael Moorcook.

[6] This notion was consolidated in the 1970s in the works of the American Philip K. Dick and the Englishman James Ballard, who inspired William Gibson. With his novel *Neuromancer* (1984), he created the manifest for the cyberpunk movement, marking the step from internal to virtual space.

[7] In various interviews, Godard stated he was not interested in the science-fiction genre.

[8] The experimentation is related to a didactic activity during the Multimedia Design Lab of the Computational Design Master Degree of the School of Architecture and Design of the University of Camerino. 2015/2016.

[9] The list includes: *Brazil* by Terry Gilliam, *Barbarella* by Roger Vadim, *The 10th Victim* by Elio Petri, *N.P. il segreto* by Silvano Agosti, *L'invenzione di Morel* by Emidio Greco, *Solaris* by Andrej Tar-

kovskij, *La planète sauvage* by René Laloux, *Alphaville, une étrange aventure de Lemmy Caution* by Jean-Luc Godard, *Metropolis* by Fritz Lang, *Zardoz* by John Boorman, *Fahrenheit 451* by François Truffaut, *H2S* by Roberto Faenza, *Stalker* by Andrej Tarkovskij, *I Cannibali* by Liliana Cavani, *The Man Who Fell to Earth* by Nicolas Roeg.

[10] In *The 10th Victim* by Elio Petri, the scenes make full reference to pop art, op art, and the boom years of Italian design in the 1960s.

[11] <www.unrealengine.com> (accessed 2018, February 3).

[12] *Oculus VR. Oculus Rift*: <http://www.oculusvr.com> (accessed 2018, February 3).

[13] Based on the novel by Stanislav Lem, *Solaris* is considered the Soviet film response of Stanley Kubrick *2001: A Space Odyssey*.

[14] The short story was published in 1971.

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The Perspective. A Matter of Points of View

Federico Fallavollita

Abstract

This article presents a study that preceded a lesson for the Department of Architecture of Bologna held to children between eight and fourteen years of age, , as part of an initiative by the University for the dissemination of science. The study presents some experiences of perspective and stereotomy. Among the objectives of the research is to explain to children, through playing, the illusory power of perspective and, therefore, the deceptions to which the human perception of space is subjected. For this purpose a small Ames room was built, studying its decomposition in parts, in a sort of contemporary stereotomy.
In the first part of the article, the lesson given to the children is briefly presented, as well as some insights on the theoretical issues addressed, which obviously could not be included in the lesson. In the second part, of the study, design and construction of the Ames room are described.

Keywords: Ames Room; Descriptive Geometry; Mirror; Perception; Stereotomy

Introduction

The starting point of the research was a lesson for children aged between 8 and 14 years under *Unijunior*. "Unique in Italy, *Unijunior* was born with the ambitious goal of bringing the youngest children closer to study important subjects, using simple and familiar tools to the child such as practical experience, play and entertainment. *Unijunior* stimulates the curiosity of the child by leveraging the natural instinct of exploration that spurs him to know the world, finding answers to his endless questions and fulfilling his priority needs" [1].
The occasion was an opportunity to gain some experiences of perspective and stereotomy. To illustrate the properties of the perspective and, at the same time, to illustrate some characteristics of the human perception of space, a plastic of polystyrene was designed, which was then realized by means of a numerical control wire cutting machine.
The intent is twofold: the first, to explain to children, through the design of the room, what the drawing of architecture is and how it differs from the commonly understood drawing; the second, equally important, consists in demonstrating the illusory power of perspective, which derives from the modalities of visual perception.
The first part of the article, briefly describes the lesson given to the children, with some other insights on the theoretical issues addressed, which obviously could not be included in the lesson. The second part describes the design and construction of the Ames room.

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Synopsis of the Lecture for Children

The original title of the lesson for children (*The world as it is and the world as it appears*) is inspired by methods of representation of architecture.
As is known, these methods are used to accurately describe and transmit forms in space and also allow us to study the mutual relations and the properties of these forms. The graphic methods are: representation in double orthogonal projections, axonometry and perspective. These methods have been complemented by digital representations: numerical and mathematical. We will not talk about the latter, because their peculiar characteristics do not change the substance of the topics covered [2]. The first two methods, i.e. the so-called parallel projections, serve to describe the 'world as it is'. The third method, or perspective, serves to describe the 'world as it appears'.
In fact, the architect uses the plan, the section and the elevation to design and measure space. He also uses axonometry to understand the relationship between volumes and the mechanism of relationships between shapes in space. Parallel projections serve, therefore, to control the metric and formal aspects of space in an environment that is isotropic and homogeneous as space itself.
But man does not see three-dimensional forms as they are: man sees space through the filter of perspective, that is, of projection that transforms the three-dimensional world into the images collected by the eye [3]. And so it becomes vital to be able to describe space as it actually appears to the human eye and for this purpose the architect employs perspective.
To explain what a perspective is, just think of a photograph, and the functioning of the eye is analogous to that of a camera. However, it would be wrong to think that the phenomenon of vision is limited to these passages of optical-mechanical nature, because, as we shall see shortly, it is the brain that processes the images collected by the eye and it is in the brain that the deceptions of perspective are produced.
In truth, the perspective question we have just touched is very controversial. We can say that there are two main distinct schools of thought.
The first considers perspective (linear and relief) only a scientific method to produce images (static or dynamic) that have the right to exist only as a product of human ingenuity, but which are not able to evoke the perception of space.

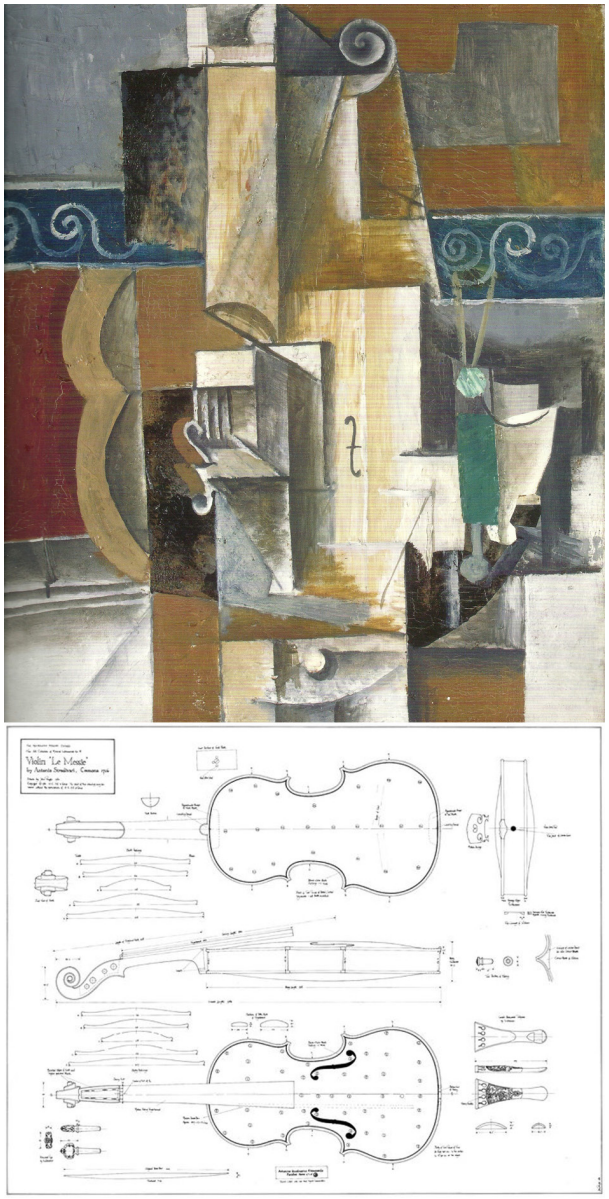


Fig. 1. Pablo Picasso, Guitar with violin, 1913. Violin by Antonio Stradivari, technical drawing.

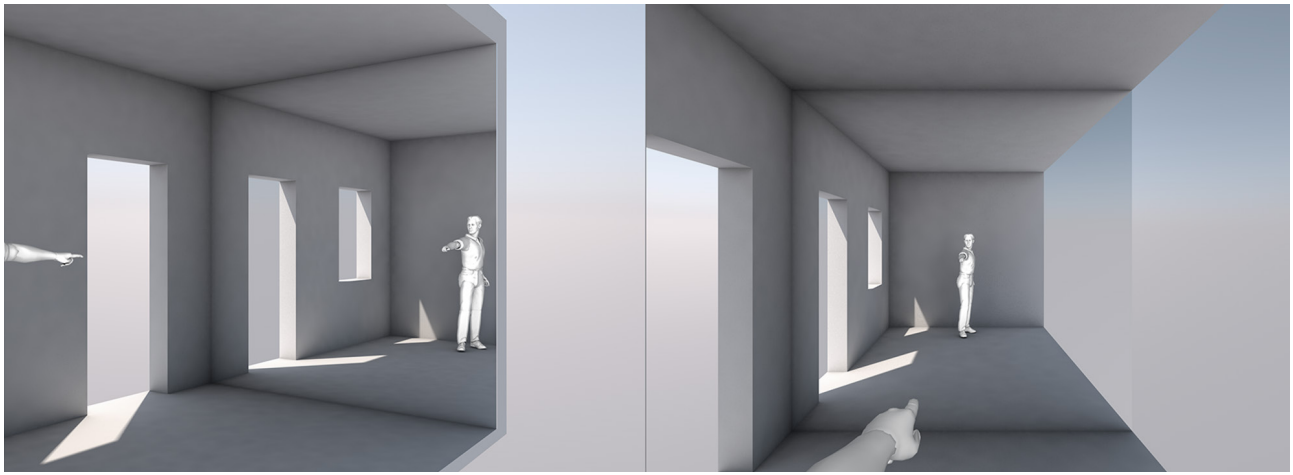
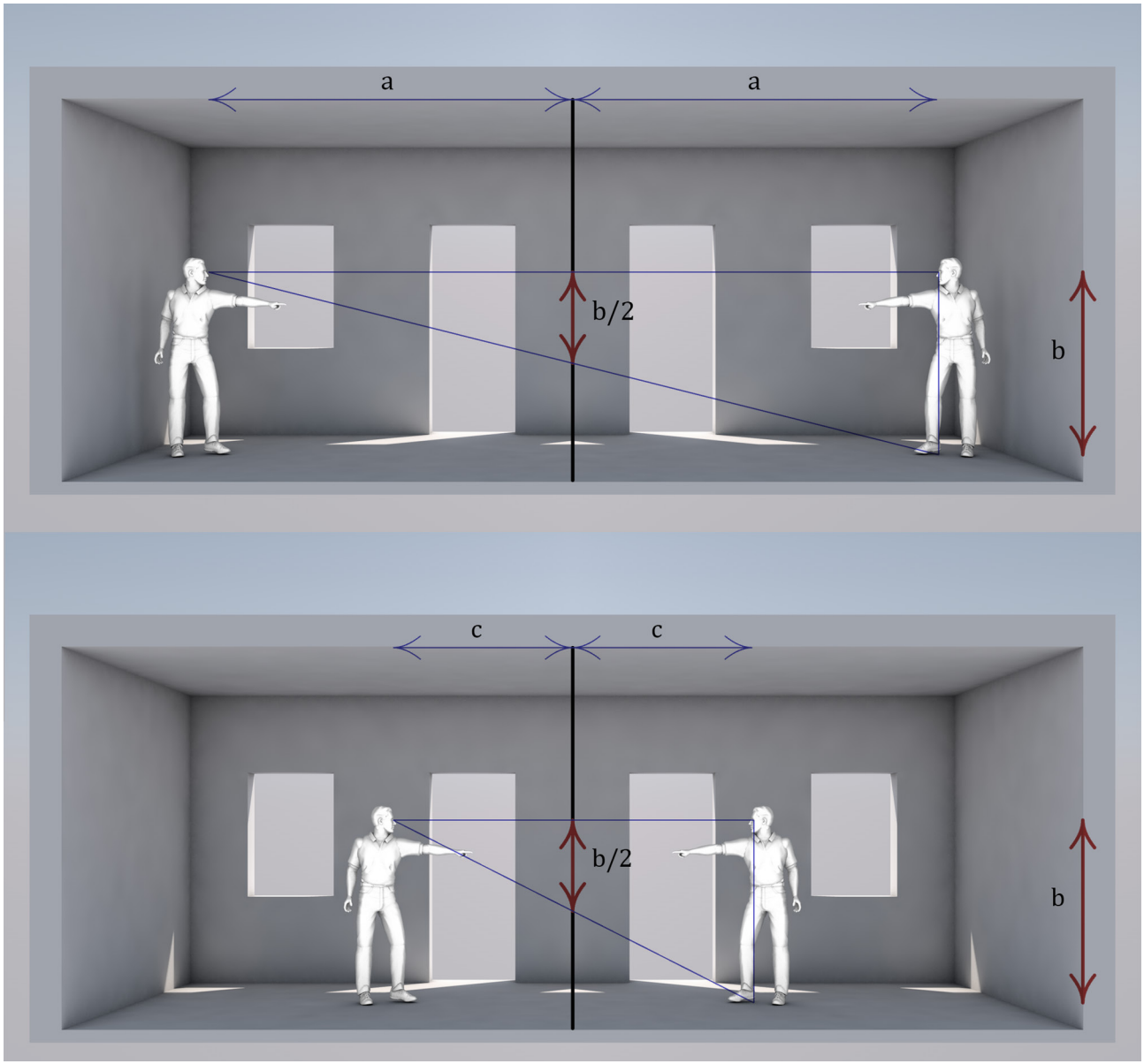


Fig. 2. The mirror image and the 'twin game'.

The second, on the other hand, considers perspective as a scientific method capable not only of describing the forms in space, but also of describing them in such a way as to evoke, in the observer, the natural vision.
In other words, according to the first school, the *perspectiva naturalis*, i.e. the vision, and the *perspectiva artificialis*, i.e. the perspective representation, are distinct and in conflict, because vision is conditioned by peculiarities, such as the curvature of the retina, that the *perspectiva artificialis* does not simulate (but the question would take us too far and refer to the bibliography for further study).
The second school, on the other hand, affirms that the *perspectiva artificialis*, discovered in the Italian Renaissance and developed to this day, is one and corresponds to the natural vision of man, being perfectly able to imitate it in its many forms, also through stereoscopy and the dynamics of cinematographic images.
In theory, an experiment could be carried out that would put an end to the dispute, but we are currently unable to put it into practice [4]. The experiment would consist in taking two photographs from a certain point of view. The first natural photograph should be taken by our eye and proposed in the mental processing of the observer. The second artificial one could be taken through a camera or built, geometrically, using the perspective method. The author is convinced that the overlapping of the two photographs, the natural and the artificial ones, would be perfect. Something very similar to this experiment was done by Filippo Brunelleschi in the early years of the fifteenth century [Fields 2005].
The difference between the two schools of thought is not a minor difference, as it involves a different vision of the history of representation and architecture. There is an important literature on this subject and the well-known essay *Perspective as Symbolic Form* of Erwin Panofsky of 1927 could be considered the progenitor of the long dispute [Panofsky 1961].
Today, the most recent studies on human visual perception affirm that man interacts with his surrounding reality through the five senses but sees reality through his own brain [5]. In other words, we never see the world as it is but we see it as our brain reconstructs it, comparing the images it receives from the eye with the models it has memorized in the evolutionary age [6].
The science that describes the methods of representation is descriptive geometry. This name is due to a French engineer and mathematician of the revolution, Gaspard Monge [7]. For years this discipline has been taught in schools and universities by engineers and then mathematicians. In the last forty years, however, especially in Italy, descriptive geometry is studied and taught only by architects and engineers. We do not want to elaborate

Fig. 3. The real world where our 'alter ego' is and the reflected world where our 'twin' is.



here the historical motivations of this change: let's just say that mathematicians have lost interest in the drawing and power of vision, even if, in the last years, thanks to the advent of digital technology, they show curiosity, if nothing else in the evocative power of images, whether realistic or symbolic.
What is the difference between the drawing of an architect and the drawing commonly understood as that of an artist or a painter?
To respond effectively (to children) it was decided to compare two representations of the same object. If we look at Pablo Picasso's *Guitar and Violin* painting we might think, at first glance, that the painter was not good at drawing or did not really like musical instruments [8]. Naturally, neither of the two statements are true. Picasso was a great drawer and was a great lover of music. The other figure shows the technical drawing of a violin by Antonio Stradivari (fig. 1).
The difference between the two drawings, that is between that of a painter and that of an architect (or a designer), is that the former interprets the form in a subjective way and transmits this emotion to the observer for empathy, while the latter, the technical drawing, measures the form and transmits it as an objective datum, aiming to remove any margin of ambiguity. This drawing must be transmissible and have a bijective relationship with the reality it represents: in other words, given a plan representation and elevation, to that correspond, in reality, the object represented and, vice versa, given a real object, it is possible to draw a plan and an elevation that match it.
Likewise, the fundamental characteristic of architectural drawing is to incorporate the code that allows us to move from reality to model and vice versa.
But can an architect use the free sketch to express his ideas as a painter? Yes, even the architect can use the drawing in a freer way, but only to follow with his mind, as with a pencil or computer, the representation of that space that can and must be measured and constructed.
Therefore, when designing a house, the method of double orthogonal projections is generally used to invent and measure space. It is also possible to accompany this study with axonometric representations to well define the volumes, the relationships between the parts and to better analyse the space. Furthermore, it is often advisable to construct a physical model, to check volumes and proportions in scale.
The perspective, instead, is used to study the perception of space, or to understand how that space will be seen and experienced, even from an emotional point of view.
The children seem to have appreciated the scientific part of the class in which the projective principles of drawing are described.
The operations that define drawing are the projection and the section. To get a drawing, we have to imagine that the sheet of paper is the picture plane, like the screen of the cinema or the computer, and there is a projection centre out of the picture plane. The image is obtained by projecting the object through the centre and dissecting the line star that derives from the picture. There may be two

Fig. 4. The size of our mirror image is always equal to the half of our real height.

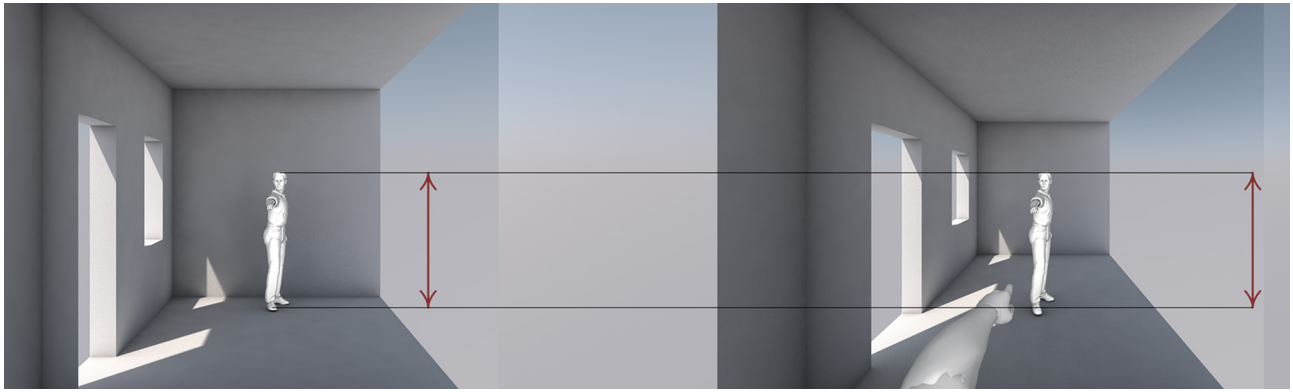


Fig. 5. Rendering of the constrained view of the Ames room digital model.

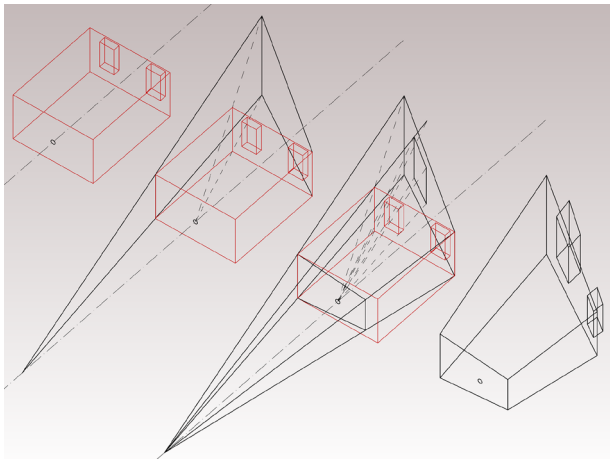
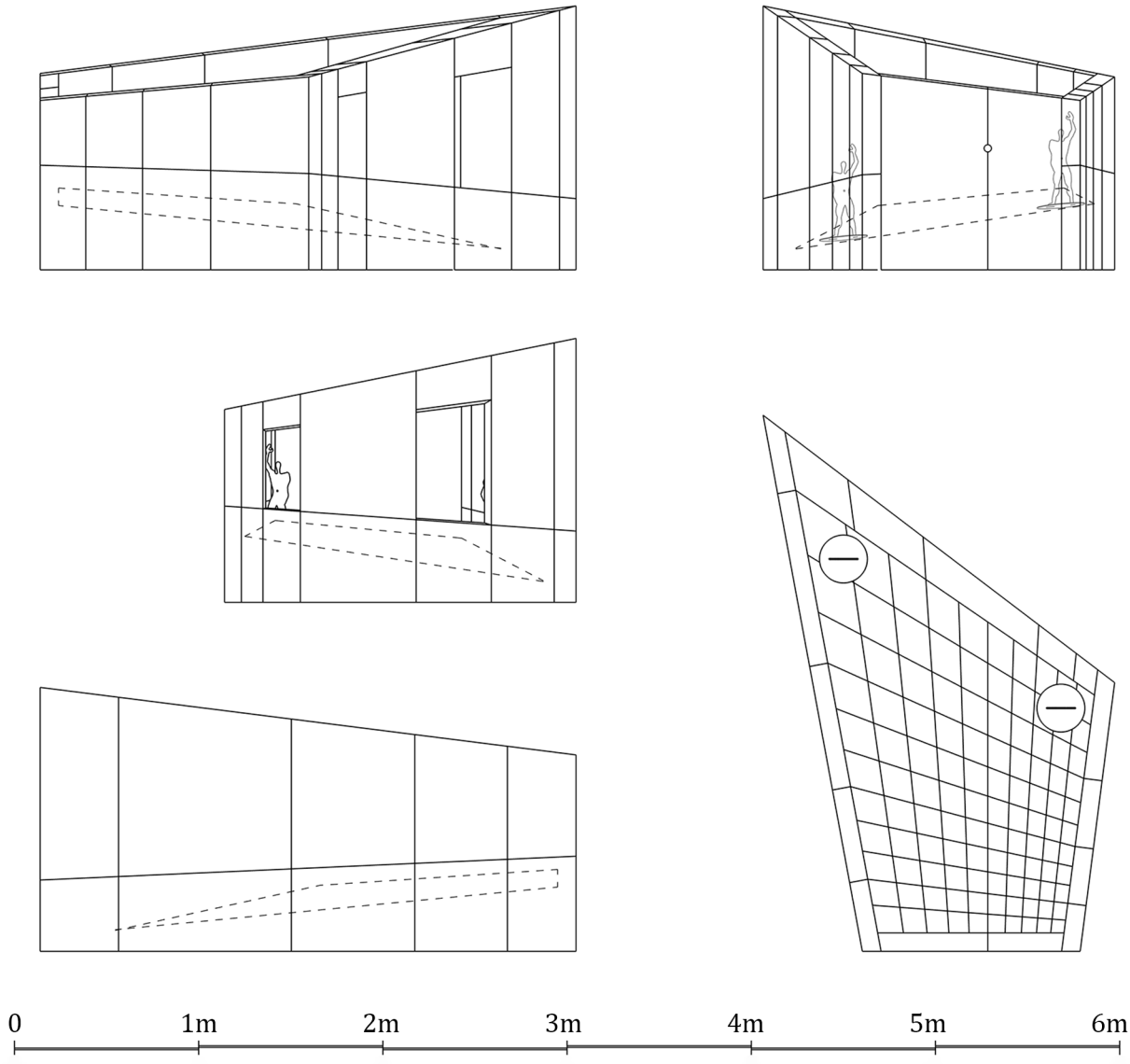


Fig. 6. Fig. 6. Projective construction of the Ames room model.

cases: in the first one the projection centre is a point that has a finite distance from the picture; in the second case, the projection centre has an infinite distance from the picture, i.e. it is very far: it is the direction of the projecting straight lines.
In the first case the drawing is a perspective, otherwise called the central projection. In the second case, i.e. the parallel projection, the drawing can be a plan, a prospect or an axonometry.
In conclusion, the former case serves to study the world as it appears and the latter serves to study the world as it is. A good architect is able to manage both situations well. However, the perspective view can be misleading, because sometimes the world is not exactly what it looks like!
What is the perspective machine we use every day?
The first answer that comes to mind might be the mobile phone camera. Well no, there is a perspective machine that we use every day from before the advent of mobile phone; this machine is the mirror (fig. 2). The mirror recreates a parallel world beyond the glass, still three-dimensional, which is exactly symmetrical of the real world. In the morning, when we wash or get dressed, we all usually mirror each other. Have you ever wondered how big your mirror image is?
Well, this image is no smaller when we move away and neither is it bigger when we approach the mirror. Our reflected image is always the same size and measures a specific quantity. To understand the problem we can imagine to observe our alter ego in front of the mirror and reconstruct the virtual world that is created beyond the mirror (fig. 3). There are two worlds: in the real one there are us and in the virtual one there is our twin. The only difference is that if we are right-handed our twin will be left-handed or vice-versa. In other words, in the symmetry of the mirror the right and the left exchange roles. If we look at the figure, it is easy to see that the distance between us and the mirror, and between this and our twin is the same and does not change with our distance from the mirror: if we approach the mirror, even our twin will approach the mirror in equal measure. If we now look at the projective triangle that forms our image, it is equally easy to see that the height of our image does not change with the change of the distance from the mirror: this height is a constant and is always half of the real one. To conclude, the measurement of our mirror image is always equal to half our height (fig. 4). To test this surprising truth, all we need to do is measure our own image on a mirror: two small signs are enough, above and below, to prove that this image will always be half our height whether we move away or approach the mirror.
The second experience, which I want to propose, to test the illusory power of the perspective vision is Ames room.

Fig. 7. The mathematical model of the Ames room.



Adalbert Ames Jnr. was an American ophthalmologist expert in optics. He is known for his experiments on visual perception which explained some fundamental principles of the visual perception. Demonstrations began in Hannover in 1938 and were carried out with the University of Princeton. These experiments are still reproduced in many departments of psychology and museums worldwide. Among these experiments, the best known and particularly peculiar is the Ames room.
The existence of this space was theorized for the first time by Fiermann von Helmholtz in 1866. He realized that objects of a multitude of different shapes and sizes can return to the eye the same image , and that a distorted room, constructed to return to the eye the same image of a rectangular room, may result in the perspective view identical to a regular room. The merit of Ames was to have built this distorted room and to have included two subjects in the room, studying its effects also on a group of volunteers. Observing the space of the room from the special hole, one gets the impression of being in front of a perfectly regular room. But if we put two subjects inside the room or facing the two windows at the back, we realize that something is wrong (fig. 5). One seems to be much bigger than the other or, conversely, if they change place, the they also change size.

We are so used to perceiving size and space in a certain way, that at first we cannot see that space is deformed and that we are not facing a regular space but a trapezoidal room. This space is specially constructed according to the projection centre which is positioned exactly in the centre of the hole. The illusion of finding ourselves in front of a perfectly regular space is disorienting; we just need to observe the space on the opposite side to immediately realize the trick.
But the most unusual feature of this experience is that even if the trick is known, the illusion does not lose its effectiveness at all: we cannot see the distortion of the room and we continue to perceive the two subjects one much smaller than the other or, vice versa, one much larger than the other. Ames is convinced that there is a memory of perception that conditions human perception, that is, the habit of living in regular spaces influences our vision and our perception. There are other theories and explanations in this regard but until now a conclusive and convincing theory that can explain this phenomenon well has not been formulated [9].
As far as we are concerned, these two experiences tell how important it is for an architect to know how to observe and represent shapes in space, both in their real form and in their appearance.

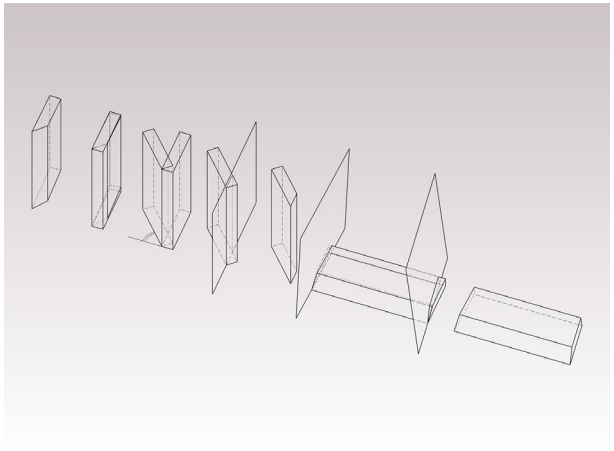
Fig. 8. Images of the constrained view of the polystyrene model of the Ames room.

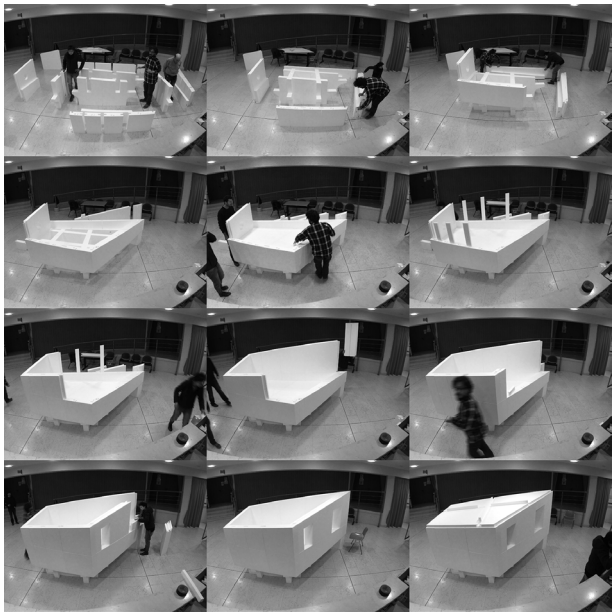
The Construction of the Ames Room

Compared to the many Ames room models built in museums, this Room was designed in parts and made of a single material. This choice, as mentioned, was dictated by the need to test the use of polystyrene and make the model safe for children.
To model the Ames room, the following procedure must be followed.
You design a regular room as you like, that is, a rectangular prismatic space that has all the walls perpendicular to each other. To make the illusion more effective you can design two regular openings on the front wall of the room. On the opposite side, on the anterior wall, chose the position of the optical hole and projection centre of the transformation. It would be a good idea to choose the height of the projection centre at the height of a man's point of view. In the case study examined this height was calculated at the height of a child.
In order to construct the transformed prism, or Ames room, it is necessary to respect the planarity of all the faces. This geometric characteristic is respected if the four faces perpendicular to the front plane, once the prism has been transformed, belong to a pyramid which has the apex on the axis perpendicular to the front wall passing through the projection centre (fig. 6). In fact, only respecting this geometric condition the four faces will all be flat: otherwise, one or more of the faces will turn into hyperbolic paraboloids.
Ultimately, in order to easily control the transformation, you can draw the pyramid axis first. The vertex of the pyramid can be chosen on this axis: the more the vertex will be close to the anterior wall, the more important the projective transformation will be and vice versa. You choose a vertical edge of the front wall to maintain a fixed position. You select an upper (or lower) vertex of the other vertical edge and project it (from the projection centre) until you meet the straight line passing through the apex of the pyramid and the upper (or lower) vertex of the anterior wall. This sets the position of the transformed vertical corner. The remaining side faces must all belong to the apex of the pyramid, or pass through that point; while the anterior and front faces are sections, always flat, of the pyramid. To construct the windows of the wall placed in front of the observer it is possible to project (from the centre of projection) on the transformed wall itself the vertices of the edges. All edges parallel to the axis of the regular prism are transformed into lines that still belong to the apex of the pyramid.
The model was designed with ashlars so that it can be assembled and disassembled (like a dry-stone wall) in a short time.
To construct the room, a mathematical model was first created and from this model the measurements of the individual ashlars were obtained (fig. 7). The scale of the model was dictated by two factors. The first was to make the children protagonists of the experience and to do so the model of the room had to be large enough. The second was dictated by reasons of external space, i.e. the model had to be small enough to easily enter inside the entrance space of the main hall of the Psychological Faculty of the University of Bologna. The final model is a room of about two meters by three, inside of which it is not possible to walk (as in the original Ames room) but it is possible to look out of the windows and observe the space directly (fig. 8).
Another fundamental choice was to build the model entirely in polystyrene in order to experiment with the construction of the ashlars using a wire cutting machine; moreover, as I already said, polystyrene is a light and safe material for children [10].
Each ashlar has been designed and modelled considering the projection centre: observing the space from the projection centre , the ashlars appear to divide the space in a regular way according to the conventional horizontal and vertical directions. In reality, the ashlars are all skewed and the faces that form such parts are not perpendicular to each other.
Initially we tried to realize the skewed segments making only two cuts. This solution, however, was immediately discarded after the first attempt. In fact, to obtain this result, the machine for processing the oblique cut had to move the two motors that carry the wire independently; doing this, however, the wire stretched too much, until it breaks. Consequently, we decided to let the motors work together and in parallel so as to avoid breaking or loosening the wire.
To obtain this result, we had to calculate the angle between the planes that form the various individual ashlars and the exact size of the regular volume that enclose each piece (fig. 9).
Starting with a piece of regular polystyrene, equal to the overall volume of the single ashlar, the various cuts were made separately, each time placing a worked piece in the

Fig. 9. Schematic illustration of the cutting stages for the construction of a polystyrene ashlar.

Fig. 10. Building of the polystyrene model at the entrance hall of the Aula Magna of Psicology faculty, University of Bologna.





machine chamber according to the calculated angles. The cuts were also designed to fit the various dry-ashlars together.
The final model is dry-mounted in about twenty minutes and can be dismantled just as easily to transport it (fig. 10). The floor has been designed as a checkerboard to accentuate the illusion of a regular space.

Conclusions

Through the game and the direct experience of space, we illustrated the illusory power of perspective and experienced the stereometric construction of a small Ames room. The children's response was positive, that is they seemed to have understood and appreciated the experiments on perspective. The lesson on *the world as it is* and *the world as it appears* will be repeated next year for the new edition of *Unijunior* 2018.
In the future, the idea is to be able to design and construct other models that can stimulate the study of visual perception and space. Regarding the question of perspective and vision, there are still open questions that would be interesting to investigate. Perspective continues to be a stimulating and mysterious theme: each time it is dealt with, it reveals its elusive and profound nature that has ancient roots. Today, living in the digital age, we have the opportunity to simulate the construction of various models and can study their potential. However, the need to physically build models that allow direct experience of those deceptions is even more surprising. Perhaps one day we will be able to definitively unravel the question of *perspective artificialis* and *naturalis*. Or the case will simply remain a matter of perspective points of view. However, we cannot forget that the experiences and research described here have been realized thanks to the geometric theory of perspective. The fact that the two experiments, the twins and the Ames room, are effective seems to bring a further element in favour of the existence of a single perspective that corresponds to the human sensible vision.

Acknowledgments

I would like to thank the architect and technical manager Davide Giaffreda and the collaborator Marika Mangano for the indispensable help in the design and construction of Ames Room's polystyrene model. The model was built entirely with the tools of the Department of Architecture; in particular, the model was realized within the Laboratory Lamo of the Department of Architecture of Cesena, scientific director Francesco Gulinello. Thanks to Fabrizio Ivan Apollonio and Riccardo Foschi for the publication of the photos. Thanks also to Valentina Orioli who has supported the initiative.

Notes

[1] The internet website of the *Unijunior* association is: <http://www.unijunior.it/> (accessed 2018, February 20).

[2] The digital methods are basically two: the method of mathematical representation and the method of numerical representation. The mathematical method describes continuously and accurately the geometric shapes in space. NURBS mathematics is the most widely implemented to describe curves and surfaces in mathematical modeling programs. On the other hand, the numerical or polygonal method describes the shapes in space in a discrete and approximate way. Polygonal shapes or mesh shapes are used to describe curves and surfaces in polygon modeling programs. Of course the two methods have advantages and disadvantages that make them suitable for some purposes. Mathematical modeling is generally used in the design phase and to accurately construct and measure shapes in space. In this sense we can say that mathematical representation is the equivalent of the two parallel projections in classical methods, namely the representation in plan and elevation and axonometry. While numerical representation is generally used to visualize and formally study shapes in space, ie to construct static and dynamic perspective and static and dynamic rendering. In this sense we can say that numerical representation is the equivalent of perspective in classical methods. Today we speak commonly of BIM or of the generative parametric representation (for example the use of visual programming languages like Grasshopper). The latter digital representations can be considered as digital representation techniques and not real methods. They do not change the geometric nature of the objects described; which can be mathematical, polygonal and hybrid. Furthermore, both techniques can be used to obtain accurate or approximate models. Unfortunately, at the state of the art there is no univocal consensus on the classification of digital methods at national and international level. The reason is naturally due to the novelty of these methods and techniques and the rapid development that these techniques are having over the years.

[3] In this context 'perceiving' has the meaning proposed by Italian Dictionary Zinagarelli 2018, that is: 'grasp the data of reality through the senses'. To avoid misunderstandings in this article I will use the terms 'to see' and 'perceive' strictly with the first meaning reported in the Italian language dictionary. It is natural that man is able to imagine and see space also in axonometry (and in double orthogonal projections). For some cultures such as Asian, in particular the Chinese and Japanese, the parallel projection method has been the main method of representing the surrounding world. And perhaps it is no coincidence that when man designs and analyses space, he is naturally led to use and prefer parallel projections.

[4] There is an episode of a British television series, *Black Mirror*, released in 2011 in which a situation is described that recalls the experiment mentioned. The third and final episode of the first season, entitled *Hazardous Memories*, is set in an alternative reality, where most people have a grain implanted behind the ear, which records everything that is done, seen or heard. This allows memories to be played in front of the owner's eyes or on a screen through a process known as 're-do', just like videos. It seems that this grain is implanted since newborns, but that a person can decide to have it removed.

[5] Here the verb 'to see' is to be understood in a broader sense.

[6] In this sense it is sufficient to think about how natural it is for man to imagine and read space in axonometry. Beau Lotto, in his essay [Lotto 2017], while not making any direct reference to the perspective, describes numerous examples that demonstrate how man reconstructs in his mind what he sees. In conclusion, even the latest theories of perception do not seem to help us on the question of perspective. Nevertheless, the scientific theses supporting the existence of a *naturalis* perspective different from the *artificialis* one are not conclusive [Gioseffi 1957].

[7] To deepen the notions and the history of Gaspard Monge and descriptive geometry refer to Cardone [Cardone 2017]. With regard to descriptive geometry and the '*scuola romana*' refer to Migliari [Migliari 2010].

[8] Picasso's painting is from 1912. While the technical drawing of the violin refers to one of the instruments construct by the well-known Italian luthier Antonio Stradivari (1644-1737).

[9] Gregory says that with the Ames room it is possible to put in place an experiment that is perhaps even more disturbing and it is able to challenge a fundamental law of physics. Simply take two objects, like two balls, and drop them. We will then see the two spheres falling at different times defying the gravitational law. Even in this case, at first glance, the impression is to be in front of objects that do not respect the same physical laws and we can not perceive that the height from which the two objects were dropped were different [Gregory 1994].

[10] The machine of the Laboratory Lamo (Laboratorio modelli di Architettura) of University of Bologna is the model 120P Box of Nettuno Sistemi; <http://www.nettunosistemi.it/120pbox.php> (accessed 2018, February 20).

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Territories and Frontiers of Representation in the Evolution of the Professions Involved

Interpret the many issues and problems associated with representation, the evolution of professional figures, changes in contexts, the need to manage and share data (GIS, BIM, etc.), and to adopt and/or experiment with infographics and forms of communication that assist in the decision-making process.

A Methodological Approach to Architectural Models as an Integral Part of the Design Process

José Antonio Franco Taboada

Abstract

From ancient times to the present day, architects and engineers have tried to express their designs in materials that allow them to transfer the creations from their mind to the tangible world, bringing them to life through models showing a future or hypothetical constructed reality. There have been more than 5,000 years between the first intuitive representations and the current immersive virtual reality prototypes, over which time the search for a universal graphic representation model has been a constant and three-dimensionality has always played an essential role [1].

Keywords: graphic representation, three-dimensionality, models and mockups.

The first 3D expressions in history

> «Jupiter [admiring at the contemplation of an extraordinary theatre] […], inwardly considered himself to be an idiot or retard, because on planning the model of the future world, instead of going to the architects of such an exceptional work he had gone to the philosophers.»
>
> Leon Battista Alberti, *Momus*, IV, p. 4 [2].

There is no doubt that initially engineers and architects belonged to the same profession and from the very start of civilisation these professionals have faced the same problem: communicating their projects to those who have to execute them, but especially to those who are going to pay for them, almost always civil and religious authorities but also patrons and private individuals.

To overcome this obstacle, they had to use all the graphic media available to them, including scale mockups of their designs. Although is tend to think that the oldest models of buildings that are conserved were not properly architectural, as Gentil Baldrich points out: «the mere votive consideration that is usually granted to them does not diminish their significance; whether they represented an ideal building or another constructed one, nothing prevented them from having been used –even to be used later– as a reference for the execution of a real work» [Gentil Baldrich 1998, p. 18].

Although mockups have accompanied the development of architecture since ancient times, the first examples that are preserved date from the third millennium BC,

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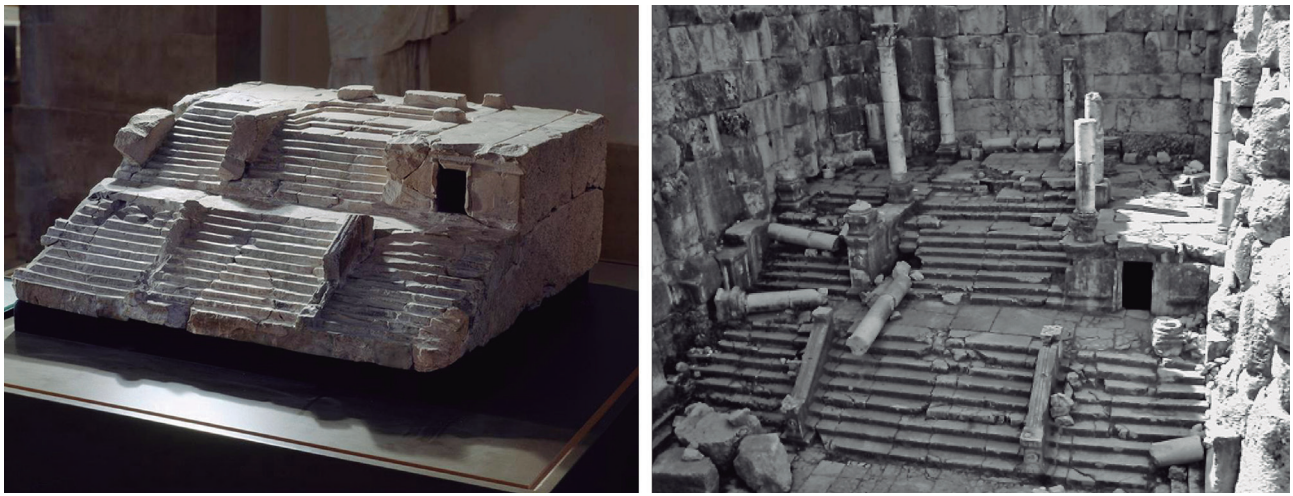
Fig. 1. Above, models of Egyptian houses in terracotta from the Middle Kingdom (ca. 1980-1759 B.C.). Schiaparelli Excavations, 1914, Gebelein. Egyptian Museum of Turin (photo by the author, 2015); bottom left, architectural model found in the ancient city of Assur, Iraq (ca. 2400 B.C.); bottom right, another example of Mesopotanian house from Syria (ca. 1350-1200 B.C.), Louvre Museum, Paris.

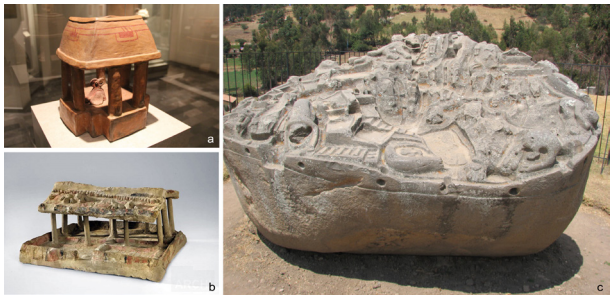
highlighting especially the so-called "soul houses" in Egypt, in which the spirits of the deceased were collected during their long journey through the afterlife. We can assume that the equivalent constructions in Mesopotamia had the same purpose, although they could also have been votive offerings to the gods or even domestic altars in the case of those with the form or façade of a temple (fig. 1).
In any case, it does not seem an absurd hypothesis to think that these mockups could have been commissioned to the most specialised professionals at that time, that is, to the architects, or that these architects presented their construction proposals using this type of model, although more elaborate, accompanied by more or less elementary planes on clay or papyri. In fact, «it is more than possible that this practice was, by simple, much more common than that of flat representation» [Gentil Baldrich 1998, p. 16].
In Greece, we know from the well-known work *Constitution of the Athenians*, attributed to Aristotle, that the city's Council of Five Hundred required architects to present their designs in the form of models or mockups, which should obviously be to scale [3]. Since Roman culture inherited many aspects from Greek culture, it is reasonable to assume that Roman architects-engineers such as Vitruvius also used mockups to convince people of the virtues of their designs.

Fig. 2. On the left, model of the adyton of the temple of Niha. National Museum of Beirut; on the right, ruined temple in 2002 [Aliquot 2009, fig. 42].



In fact, unique and exceptional proof of the existence of mockups as design tools in Roman times has been preserved, namely the entrance to the *ádyton,* place reserved for the priests, in the Phoenician temple of Niha, in the Bekaa plain (Lebanon), dating back to the 2nd century AD, today in the National Museum of Beirut (fig. 2). In the building, also known as the Great Temple to differentiate it from the others in the same area, its adyton is practically the same as the model used to build it, although with the slight modifications inherent to the constructive reality.
The mockup, in calcareous stone, is built to a 1:24 scale and as Aliquot points out: «*L'inscription gravée dans un des angles de ce monument ne laisse aucun doute sur sa fonction: modèle de l'adyton (προκέντμα αδύ [του]).*» However, according to that same author, and as happens today, the model was not produced by the architect but by one of his assistants and «*semble bien supposer un plan et un plan pratiquement dessiné à la même échelle.*» That is to say, the creation of the mockup is the materialisation of a previous plan produced by the architect that «*illustre le rôle du dessin d'architecture dans l'Antiquité en général et dans l'édification des temples romains du Liban en particulier, celui d'un modèle destiné à être reporté, mais susceptible d'adaptations*» [Aliquot 2009, § 59]. Or in other words, the mockup plays a secondary role to the drawing.
Rabun Taylor holds a similar opinion and considers that the most valuable mockup is one of the least discussed, a 1:30 scale fragment of the Great Altar of Baalbek that stands out for its spatial complexity, the result of a perfect analytical plan. This author states that «*The obvious benefit of the models does not obscure the likelihood that for Roman architects themselves, as opposed to the stonemasons and bricklayers, perspective drawings were the most important creative aids.*» He provides support for his position with the testimony of the Roman lawyer and writer from the second century, Aulus Gellius: «*Fronto's builders presented rival plans and "specimens" for a proposed bath building in the form of paintings on parchment (depictas in menbrenulis varias species balnearum)*» [Taylor 2003, p. 36]. In any case, what we can conclude is that both the perspective drawings and the scale models not only coexisted as tools of representation, but also complemented each other.
As is logical, there are many other examples of architectural models from ancient times, regardless of the motivations for their execution, such as the Neolithic ones of the Germanic or Slavic peoples, the Etruscans, etc. Also noteworthy are the oriental ones, with unique models of houses or temples in China and Japan, in materials such as bronze and ceramics.
Worthy of a separate mention are the Pre-Hispanic Mesoamerican mockups (fig. 3a), analysed in detail in the work of Daniel Schávelzon, who cites one found in 1932 with the same function as that of Niha: it is a Zapotec temple in Tomb 7 of Monte Albán, which the archaeologist Alfonso Caso identified «as the scale representation of the building that existed on top of it» [Schávelzon 2004, p. 29]. Examining the Mesoamerican architectural representations and numerous scale mockups results in a surprise due to the parallels between them and the Egyptian and Mesopotamian ones. Similar and even more abundant are the pre-Columbian mockups from South America from the same period and, specifically, those of the Andean civilization, such as the Moche ones in modelled clay (fig. 3b).
This civilization reached its maximum splendour with the Inca culture, from which remarkable examples have been preserved. Perhaps the most famous, which has been represented in a commemorative coin, is the Sayhuite monolith in Curahuasi, Peru (fig. 3c), a large block of granite about two and a half metres tall that is believed to date back to the 15th century, the time of the so-called Inca Empire (15th and 16th centuries), at the height of this civilization. What makes it special is that it shows land with people, buildings, staircases and hydraulic works such as channels and ponds, which could be, among other theories, a kind of stone plan or sketch made by Inca architects or engineers to oversee the works they carried out [Garayar 2003, p. 176].
Meanwhile, in Europe the Italian engineer born in Cremona, Giovanni Torriani, known in Spain as Juanelo Turriano, carried out one of the most important engineering works of that time. It is an extraordinary hydraulic machine, reminiscent of those previously designed by Leonardo da Vinci, to raise the water from the Tagus River to the Castle and city of Toledo, overcoming a height difference of over 90 metres. No longer standing today, it can be seen in the View of Toledo by El Greco, ca. 1599-1600 (fig. 4).
It is documented that Turriano made at least two mockups of his artifice, and could have sent one to his country of origin. This model, which was built by Juan Luis Peces Ventas according to the investigation of Ladislao Reti, Ventas, is probably similar to those that have been lost.

Fig. 3. a) Clay model of a Zapotec temple (100 B.C.-100 A.D.), found in Mount Alban II. National Museum of Anthropology, Mexico City; b) clay model representing a complex with a main roofed platform and decorated panels (200 B.C.-600 D.C.). San José de Moro Archaeological Programme; c) the Sayhuite or Saywite monolith, in Curahuasi, Peru.



The renaissance of the arts and the pursuit of spatial depth

Although is tend to think that the humanist architect, often also a painter, used perspective as a main vehicle for the expression of his ideas, in reality it seems that his fundamental design instrument was the mockup, usually made of wood, which has led to few copies have reached our days.

In the Renaissance, the Athenian model continued and patrons demanded mockups, especially when inviting more than one architect to enter a competition such as that for the dome of the cathedral in Florence, which involved Brunelleschi and Ghiberti. The first of these gave us the best example of a mockup as a construction model, which was discovered relatively recently behind the apse of the cathedral. Almost three metres in diameter, even the bricks are to scale, showing the famous herringbone arrangement that the architect was wise enough to hide from his competitors. This well-known and important finding shows that Brunelleschi, in addition to knowing how to make mockups to win competitions (fig. 5a), made "models" to scale to be able to experiment with his new construction techniques, without any risk to the building work.

Fig. 4. On the left, reconstruction of Turriano's artifice, on permanent display in the Provincial Council of Toledo (photo by the author, 2017); on the right, View of Toledo, by El Greco. Metropolitan Museum of Art, New York.

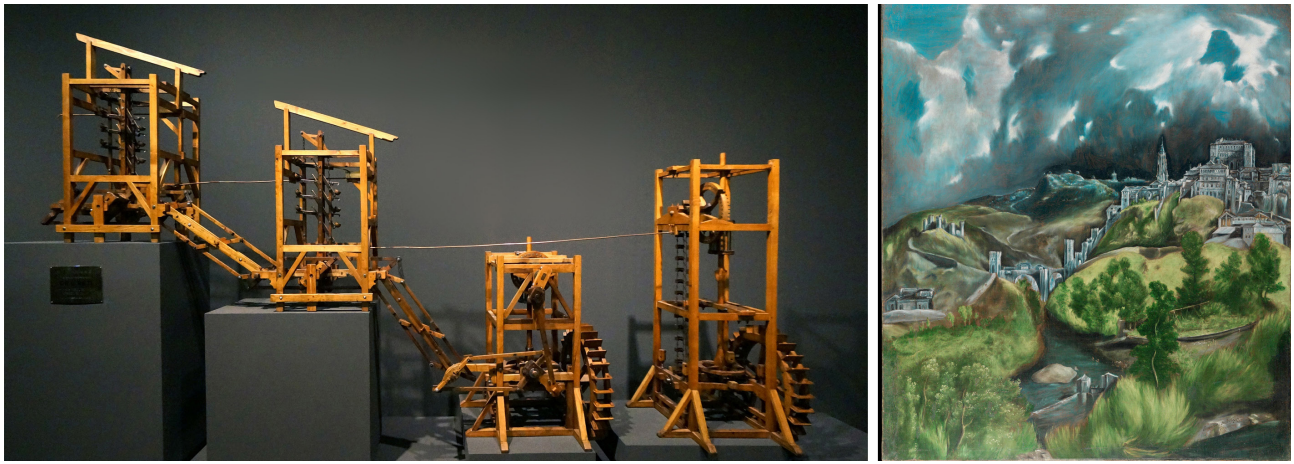
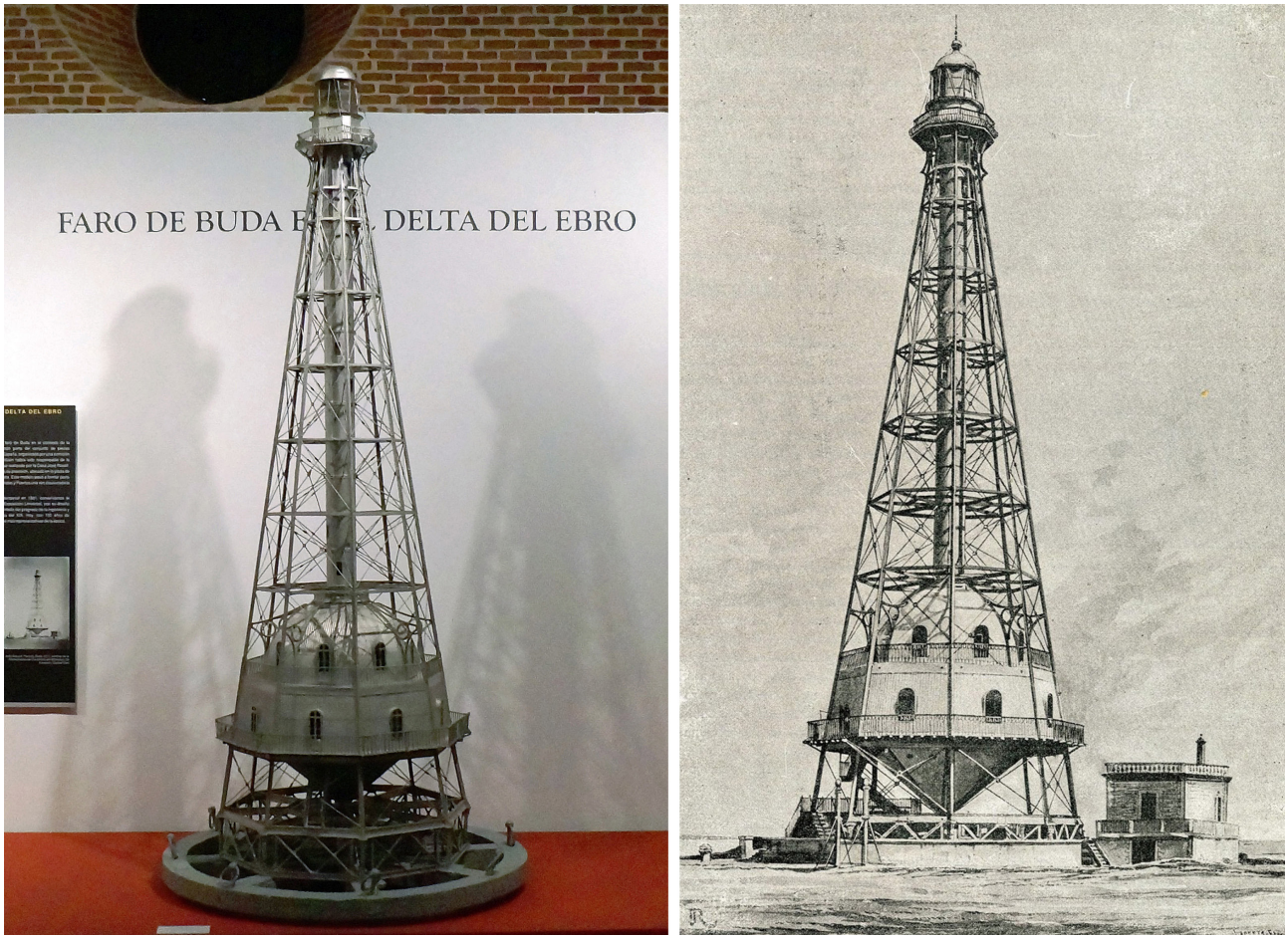


Fig. 5. a) Brunelleschi's wooden model of the dome and sections of the apse of Florence Cathedral; b) above right, the "Great model" of St. Paul's Cathedral in London, 1672-1673; c) wooden model of the Filippo Juvara design for the reconstruction of the castle of Rivoli by Carlo Maria Ugliengo in 1718. Palazzo Madama, Turin (photo by the author, 2015).

In the following centuries architects perfected their graphical representation systems and techniques, including mockups, which continued to be their main resource, such as the one that Sir Christopher Wren produced in 1669 for St Paul's Cathedral, London (fig. 5b). As John Wilton-Ely states, «Wren brought to architectural design a scientific cast of mind that found its expression in such experimental and explanatory aids as models» [Wilton-Ely 1977, p. 186]. Wren thus continued with the tradition begun by Alberti, for whom architectural mockups were not a means to present an idea to a client, but an instrument for the study and development of a design, which could only be completed by using them [Millon 1996, pp. 24, 22].
We find one possible example of their use for explanatory purposes at the Palazzo Madama in Turin, in which one room is practically dedicated to the large mockup that

Fig. 6. On the left, model of the Buda lighthouse. Leonardo Torres Quevedo Museum of the Technical University of Madrid (photo by the author); on the right, engraving based on a photograph published in the magazine El Mundo Naval Ilustrado, No. 51, June 15, 1901, p. 256.



Filippo Juvara made for the reconstruction of the castle of Rivoli in the 18th century, to a scale of approximately 1:50. According to that institution, which houses the collection of the Civic Museum of Art, the order of assembly of the pieces respects, as far as possible, the logic of the steps for the construction of the castle, which could suggest that it was used as a guide during the building work (fig. 5c).
During the 19th century, and as Millon points out, the use of mockups was scorned by the programme of the École des Beaux-Arts, which led to this ancestral tradition declining in popularity [Millon 1996, p. 72]. However, this period saw the start of iron or metal architecture as a direct consequence of the Industrial Revolution and this was also used in the scale representations, with such important projects as the Crystal Palace of Joseph Paxton for the Universal Exhibition of London in 1851 or the Eiffel Tower for the one of Paris of 1889. One example of some importance in Spain was the Buda Lighthouse in the Ebro delta, designed by the engineer Lucio del Valle, whose model made by a precision instrument workshop in Barcelona, was presented at the Universal Exhibition of Paris in 1867 (fig. 6). Given that the lighthouse was destroyed in a storm in 1961, its 150-year-old mockup is even more important.

From modernity to the information age

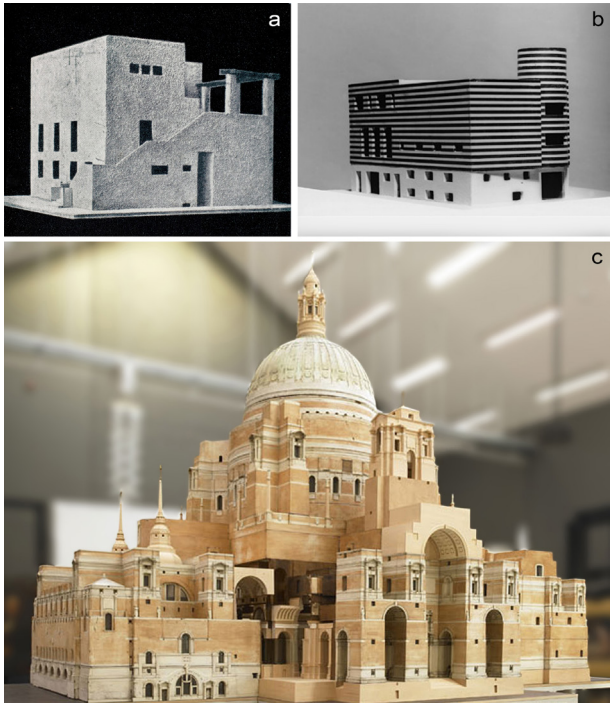
"Functional architecture" prioritised axonometric representation, and therefore mockups, whose vision is very close to that, over linear perspective. Therefore, the modern movement did not change technicians' methods of bringing their projects life. However, it might have simplified their elaboration in both two and three dimensions, in line with the new architecture, which continued to use the mockup as a fundamental tool to communicate ideas and resolve structural or construction problems.
Antonio Gaudí stands out among the pioneers of the first waves. He took a step forward in the use of mockups for this purpose with the inverted models of his works, in which he used strings and small weights to achieve the anti-funicular of the loads so that the structure essentially worked under compression (figs. 7a, 7b).
In Spain, the mockups produced by Antonio Palacios[4] also stand out. Together with his partner Joaquín Otamendi, he won the 1904 international competition for the new post office in Madrid, known as the "Palace of Communications".
The building is clearly influenced by both late Gothic Spanish architecture and by the sublimation of this style developed by Viollet-le-Duc and, conceptually speaking, by the Vienna Secession. Its most original feature is perhaps its metal structure, which in some parts of the building is exposed in the style of Viollet-le-Duc (fig. 7c).
The enormous plaster and wood model produced for the competition shows the ambition and complexity of the project, as well as the importance of this form of representation, which has been a constant in the history of architecture and other disciplines such as engineering.

Fig. 7. a) Reconstruction of Gaudí's structural model for the church (not built) of the crypt in Park Güell (Barcelona), displayed in the Gaudí Centre in Reus (Tarragona). In the lower mirror, you can see the final form the building would have had (photo by the author, 2010); b) sketch of the exterior of the Church of Colònia Güell, by Gaudí (1898-1908); c) plaster model of the "Palace of Communications" in Madrid, work of Antonio Palacios. Mundo gráfico, Year II, No. 35, 26 June 1912.

In this latter field, mockups have been particularly useful, both to inform and to demonstrate the operation of certain engineering works, especially those that are as ahead of their time such as the Niagara Aero Car, which is still in operation and has just celebrated its "first centenary" (fig. 8). At 549 metres long and 76 metres tall, it was inaugurated in 1916 and is the only one of its kind still in operation. Its creator, «Leonardo Torres Quevedo (1852-1936) was an ingenious Spanish engineer. Among his creations were algebraic machines, remote control devices, dirigibles and the world's first computer», as the plaque at the entrance says.
Beyond their function, as either tools of representation or constructive or experimental models, some mockups have transcended their own field, becoming part of the history of architecture in their own right. Adolf Loos's unbuilt design for the house of the famous dancer and singer Josephine Baker would hardly be remembered if it were not for his 1927 mockup currently in the Albertina Museum in Vienna (fig. 9b). The vibrant alternating of the parallel bands of the façades of its upper floors remind one of the ancestral images from thousands of years ago of the façades of Minoan houses, but above all bring to mind the more recent ones from medieval Tuscany. According to Benedetto Gravagnuolo, the "Mediterraneanness" of the image, confirmed by its flat roofs, architectural introversion, recovery of two colours and plastic reduction are evident [Gravagnuolo 1982, p. 191]. Except for the two colours, we could also apply these observations to designs such as the villa for Venice Lido, from 1924, which reminds us so much, with rationalist language, of the ancient "soul houses" (figs. 1, 9a).
In contrast to the still present modernity of Loos' works, we have the design by the English architect Sir Edwin Lutyens, presented in 1933 as a proposal for Liverpool's Catholic Cathedral, which did not end up being built (fig. 9c). It is one of the most elaborate wooden mockups seen in Great Britain, surpassed only by Wren's "Great model".
At the same time as Antonio Palacios and Sir Edwin Lutyens were still designing in the beaux-arts style, in 1932 the architect Philip Johnson and the historian Henry-Russell Hitchcock organised the first International Exhibition of Modern Architecture at the Museum of Modern Art in New York, MoMA. In this, the models replace the real and impossible experience of the architecture, complementing the photographs and drawings. The exhibition was organised as a touring exhibition visiting the main cities in the United States to give maximum possible publicity to the "good news" of the recently baptised "international style", which Johnson described as follows: «The 'International Style' is probably the first fundamentally original and widely distributed style since the Gothic» [5].
This exhibition represented a turning point in the use of mockups, greatly influenced by the fact that architects such as Antoni Gaudí, Mies van der Rohe, Le Corbusier and Frank Lloyd Wright had used these models in very varied ways, thus contributing to the revival of this ancestral tradition [Millon 1996, p. 72].
However, the use of scale models, before the development of computer systems to calculate structures through graphic design interfaces such as Rhinoceros, has its greatest exponent in the model that Frei Otto (1925-2015), a student of Gaudí, produced for the calculation of works such as the Olympic Stadium in Munich in 1972 (fig. 10a).
In the great exhibition about his work held in Karlsruhe, which closed in March of this year, given the expressive

Fig. 8. Scale reproduction of the aero car made of brass and steel in 1915. Leonardo Torres Quevedo Museum of the Technical University of Madrid (photo by the author).

Figure 9. a) Venice, Lido, Villa by Adolf Loos, 1924 [Sartoris 1932, p. 60]; b) Josephine Baker's house, Paris, 1927; c) model of the Lutyens design, 1933.



title *Frei Otto Thinking by Modelling*, it can be seen that in his work, mockups and models represent a renewed attention to the world of craftsmanship. In the line dictated by the principles of the Bauhaus: «This consideration of physical and craftsmanship aspects has also placed a renewed focus on the history of models and its experimental function in architecture, art and science. The question concerning materialization of information is of great significance in this context» [6].

When applied to mockups, the term "experimental" acquired a new dimension with the exhibition held by the Royal Academy of London in 1986, called *New Architecture: Foster, Rogers, Stirling*, dedicated to these three architects, which in addition to bringing together their most recent works, offered them the possibility to show new ideas or unconstructed "provocations" [7]. The best known is that of Rogers, who presented a large mockup entitled *London as it could be*, which aimed to reinvent central London, reintegrate the city with the Thames and give priority to pedestrians instead of cars (fig. 10b). It is clearly a utopian design that emphasises the possibilities of the model to influence the future of architecture.

Mockups became increasingly important throughout the twentieth century, to the extent that they were even considered historical-artistic monuments in themselves. An example of this can be found in one of the pieces in the *Frank Lloyd Wright at 150: Unpacking the Archive* exhibition, held between 12 June and 1 October 2017 at MoMA. This is the mockup of St. Marks Tower, an unbuilt design developed between 1927 and 1931, which was presented

Fig. 10. a) Frei Otto working on a model of the pavilions of the Olympic Park in Munich; b) Richard Rogers at the New Architecture exhibition at the Royal Academy in London, 1986 (photo by Tim Mercer).

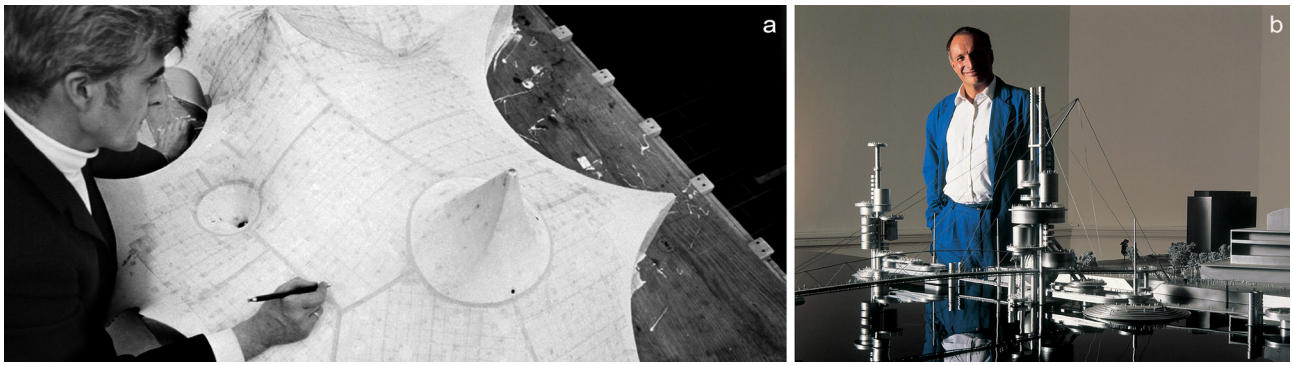


Fig. 11. On the left, historical image of the model of St. Mark Tower, Art Institute of Chicago, 1930; in the middle, model state before restoration, 2013; on the right, during the process.

not only as a representation of an architectural design, but as a work of art in itself (fig. 11). On the Museum's website about the exhibition one can find information about its conservation and watch a video about the restoration process, which give an idea of the time and resources involved in this. This demonstrates the importance of these models beyond their historical value, especially in the case of a design that was never implemented, in which the mockup to some degree replaces the unbuilt work.

The new millennium: the example of Herzog & de Meuron

The end of the 20th century saw the accelerated development of computer drawing programs. Since then, when the promoter faces 3D images from what could be called "digital" or "electronic" mockups, which due to their realism seem to reflect the work already finished, his ability to imagine it suffers. It is at that moment when they become photographs in the sense that Susan Sontag gave them in her famous essay *In Plato's Cave* of 1973, when graphic computing had not yet been developed: «A photograph is both a pseudo-presence and a token of absence» [Sontag 1981, p. 12]. If we consider, for example, Takehiko Nagakura's black and white infographic of the inside of the Palace of Soviets, designed by Le Corbusier for Moscow in 1931 (fig. 12), only our intellectual knowledge that this building was never built forces us to abandon the idea that this is a photograph taken from a magazine at that time.
The most emblematic example of this technological development is the Hamburg Elbphilharmonie (fig. 13), by the Swiss architects Jacques Herzog and Pierre de Meuron. The evolution of the project from the first drawings in 2001 to the completion of the work in early 2017 ran almost hand-in-hand with the century and with the great advances in graphic representation systems and techniques, many of which –if not all–, were used before, during and after its conclusion.
This new icon of the city –already popularly known by the nickname *Elphie*– has had to overcome a raging sea of negative criticism because of the huge delays in its construction and the disparity between the initial budget of €77 million and the final cost of €789 million, criticism that was somewhat akin to the gigantic wave it evokes.
To overcome these difficulties, those involved in the project had to convince not only their institutional client but also those supporting it, that is, the public. For this, they used the classic weapons of the architect, the drawing and mockup, but took them a step further with the help of technology.
Among the mockups used we can emphasise the scale model of the auditorium or "Great Hall" of the Elbphilharmonie, reproduced in wood, weighing 4.5 tons and built at a cost of €200,000. This mockup was used by the world-renowned expert Yasuhisa Toyota to design the acoustics and to calculate the shape and surface of each of the more than 10,000 tiles that line the room, all different so that they reflect the sound in a certain way.
This characteristic "white skin" [8] –as it has been called–, together with the soft shapes of the room, mean that the space «*looks a bit like a limestone cave*», as described by Toyota when he visited in 2014 [Mischke, Zapf 2017, p. 180]. Interestingly, this description coincides more with the vision of Jacques Herzog, who expressed his desire that «the 'white skin' would in the future no longer be known by this name», since it reminded him «far more of something mineral, of a cave, of a sense of 'nurturing containment'» [Mischke, Zapf 2017, p. 177].
In addition to physical mockups, the architects used other virtual ones with hugely realistic 3D representations, virtual reality visits or a spectacular tour with drones inside and outside the building starting with a flight over the endless escalators that remind us, of course, of those in London's Tate Modern, by the same authors[9].
The resources spent on the promotion of the project were supplemented, during the building phase, by the creation of the Elbphilharmonie Pavilion, an elementary and elegant cubic construction where, as a type of "interpretation centre", the final outcome of the work in progress was explained to visitors (fig. 14a).
Inside the cube was hidden the mockup of the "Great Hall", which people could access by climbing a ladder and putting their heads through a small circular hole located in the centre of this reproduction on a 1:10 scale. This position gave a 360° view, like a virtual-real panorama: «Looking at the model, one can get a good spatial impression of the concert hall» [10] (figs. 14b, 14c).
Despite the amount of resources involved, the modern BIM technique was the most overlooked element in the first phase of this gigantic construction (fig. 15). According to the German Ministry of Transport, this was the cause of the immense gap between the €77 million originally budgeted and the €789 million that it ended up costing (people are already talking about 860), declaring in 2014

that the modern construction must first be virtual and then real: «*Erst virtuell und dann real bauen*» [11]. BIM techniques were subsequently implemented and thousands of conflicts were found such as inadequate connections of facilities and structural problems that fortunately could be resolved, but at a high price.
However, it was undoubtedly the appeal of the drawings and models used by the architects what allowed them to finally overcome so many difficulties and finish what surely will end up being the symbol of modern Hamburg.

The future

Perhaps the main lesson that can be drawn from the history of representation is that however advanced and innovative the method used to bring a project to life, and however seductive or appealing its result, this may not be sufficient. Technology must be used to support construction in the most classic meaning of the word: "doing something using the right elements", and not just to put on a good show.
J. C. Golvin and R. Vergnieux affirmed, in relation to the

Fig. 12. Virtual reconstruction of the interior of the Palace of the Soviets, designed by Le Corbusier for Moscow in 1931 (infographic by Takehiko Nagakura, 1997-1998).

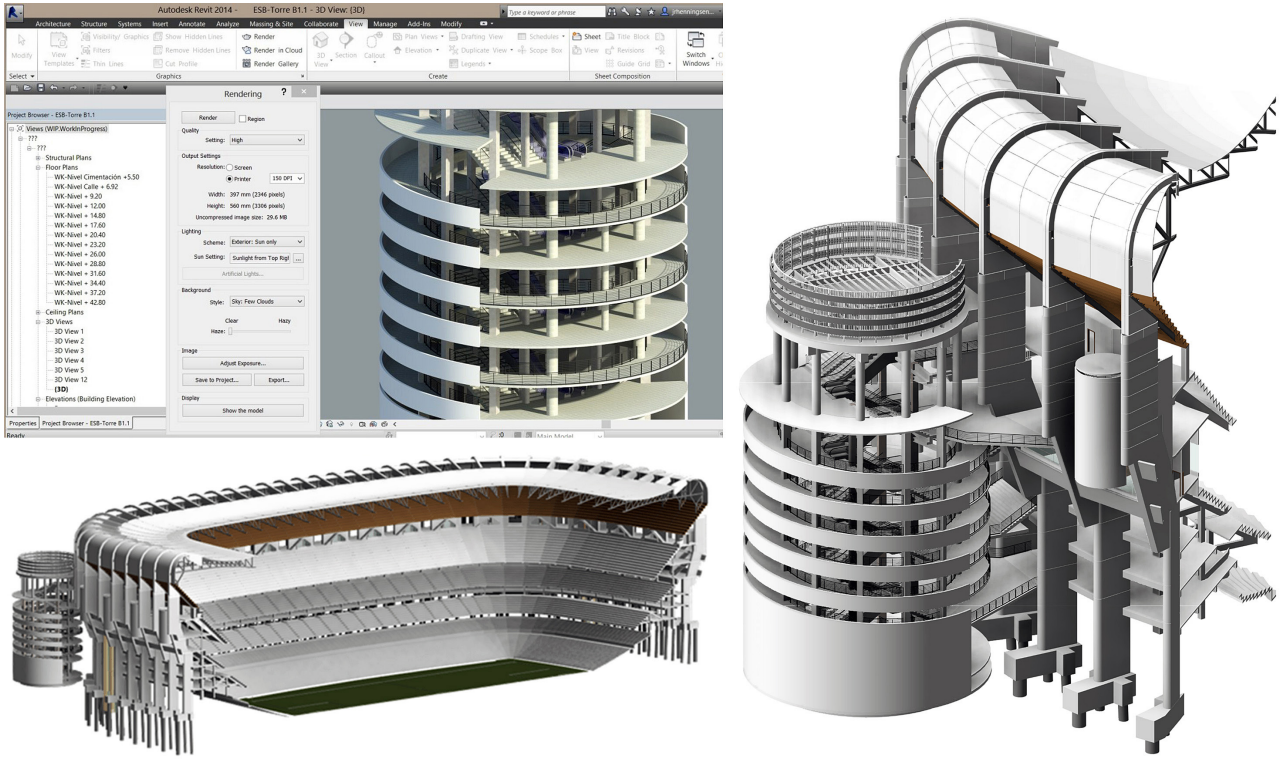
Fig. 13. On the left, canonical image of the Elbphilharmonie design by Herzog & de Meuron, exhibited in the Elbphilharmonie Pavilion (photo by the author, 2009); on the right, image of the Elbphilharmonie (Photo by María Martul, 2017).

Fig. 14. a) Elbphilharmonie Pavilion with its exterior speakers playing music from the Philharmonic; b) cylindrical 360° virtual reality image of the scale model of the auditorium; c) partial detail with dummies dressed in felt for the sound study (photo by the author, 2016).

constructions of the past, that «the restored image constitutes an important and indispensable stage between the scientific analysis of the documentation and the production of the research instrument which is the electronic mockup of the ancient buildings» [12]. However, what the Elbphilharmonie example demonstrates is that this statement is as applicable to constructions that no longer exist as it is to those yet to be created, that is, to the future.

Digital models allow us to reconstruct buildings that no longer exist, but also to determine how the ones in our imagination should look, which does not imply that other forms of representation such as traditional mockups are no longer valid. The above is clearly demonstrated by the scale model of the "Great Hall" and the work of current architects such as Frank Gehry, in which the alternation of "analogue" and "digital" mockups constitutes a feedback

Fig. 15. BIM model of the "Santiago Bernabéu" stadium with structure, architecture and facilities, based on drawings made in CAD and 3D scans (photomontage made with images from the DEMO Group).



process that gradually leads to the proper definition of the architectural design.
In any case, and as Henry Millon points out [Millon 1996, p. 72], «A history of architectural models as an integral part of the design process has yet to be written».

«What happened in the past is no longer; the future
is not yet lived; what is present
is not here, because movement is its essence.

What is unknown is only the certain,
this world, republic of wind,
which has an accident for a Monarch.»

Gabriel Bocángel, *Sonetos* [13]

Notes

[1] This work is included in the Consolidation and Structuring Programme READS 2016 (ED341D R2016/023) of the Government of Galicia; and the project HAR2016-76097-P (AEI/FEDER, UE), affiliated to the National Programme for Fostering Excellence in Scientific and Technical Research, State Subprogramme for Knowledge Generation. This article develops the introductory presentation of the author in the XXXIX Convegno Internazionale dei docenti della Rappresentazione *Territori e frontiere della Rappresentazione*, Naples, 14-16 September 2017.

[2] The edition princeps of *Momus* can be consulted and downloaded at: <https://ia800700.us.archive.org/1/items/ita-bnc-mag-00000703-001/ita-bnc-mag-00000703-001_text.pdf> (accessed 2018, November 17).

[3] Adam, J.P., Dibujos y maquetas: la concepción arquitectónica antigua. In Azara 1997, p. 31.

[4] Between 1930 and 1932 Antonio Palacios created a major town plan for the Spanish city of Vigo, which had it been carried out would have led to the disappearance of its historic centre. In any case, the large scale model he presented was crucial to gaining its initial approval, although it was then halted by the outbreak of the Spanish Civil War in 1936.

[5] Even if it was generally attributed to Philip Johnson, this sentence seems to come from Alfred H. Barr, director of MoMA at the time of the vernissage of the exhibition *Modern Architecture* in 1932, February 10. See press release about the exhibition in <https://www.moma.org/documents/moma_press-release_324965.pdf> (accessed 2018, February 4).

[6] *Architecture as a presumed future. Symposium Frei Otto. Thinking by Modelling*. Thu, 26.01.2017-Fri, 27.01.2017, ZKM_Media Theater: <http://zkm.de/en/event/2017/01/architecture-as-a-presumed-future> (accessed 2018, November 17).

[7] In the words of Owen Hopkins, manager of the Royal Academy's architecture programme, who also tells a curious anecdote about the inauguration, according to which Jim Stirling smuggled a live fish into Rogers' model (in the comments on his article people confirm that the fish was absorbed by the whirlpool created by the circulating pumps of the mockup and instantly cut into a thousand pieces). Hopkins, O. (2014). How do you make an architecture exhibition? In *Royal Academy of Arts* 11/01/04: <https://www.royalacademy.org.uk/article/how-do-you-make-an-architecture> (accessed 2018, November 17).

[8] This unique inner lining was developed through complex 3D calculations and using the microshaping technique, which according to the definition of the company producing it is the calculation of the individual surface structure of each piece of the "white skin". No panel is identical and the honeycomb structure is not repeated. The 3D CAD data became machinable CNC programs in the production planning process of Hasenkopf : <http://www.hasenkopf.de/en/projects/elbphilharmonie-hamburg> (accessed 2018, November 17).

[9] <https://www.elbphilharmonie.de/en/worldwide/slow-and-motion> (accessed 2018, November 17).

[10] Kämpermann, M. , Hotes, K. (eds.) (2014). *Elbphilharmonie Hamburg*. Hamburg: HamburgMusik gGmbH and Elbphilharmonie und Laeiszhalle Betriebsgesellschaft, p. 15.

[11] Kammholz, K. (2014). So will Dobrindt Debakel wie die Elbphilharmonie verhindern. In *Hamburger Abendblatt* 15/05/14: <https://www.abendblatt.de/politik/deutschland/article128026556/So-will-Dobrindt-Debakel-wie-die-Elbphilharmonie-verhindern.html> (accessed 2018, November 17).

[12] Golvin, J.-C., Vergnieux, R. Primer análisis para la elaboración de una maqueta electrónica del santuario del gran templo de Atón en Amarna. En Azara 1997, p. 40.

13] Gabriel Bocángel (1603-1658), was a Spanish poet and writer of Genoese ancestry and chronicler of the court of Philip IV of Spain.

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The BIM towards the Cadastre of the Future enhanced through the Use of Technology

Anna Osello, Francesca M. Ugliotti, Daniela De Luca

Abstract

Knowing, digitalizing, sharing represent the key concepts of this millennium. The construction and Real Estate sectors have the opportunity to take up this challenge by becoming promoters of intelligent data management that characterize buildings. The Building Information Modelling *(BIM) methodology, strengthened by the unstoppable technological progress, lays the groundwork for re-designing a structured knowledge system of the building heritage. This triggers a new concept of Cadastre of the Future, dynamic and updated, which interrogates the* Big Data *of the buildings according to a multidisciplinary and interoperable approach. The perspective is ambitious, but it is essential to define the correct methodological approach to govern the digitization of built heritage. The setting up of the first experimentations is carried out on the City of Turin. Pursuing the vision of augmented digital city, an interactive map has been created, exploiting new technologies, such as Augmented and Virtual Reality, to enable the dissemination of information to different types of users.*

Keyword: Building Information Modelling, Cadastre of the Future, Big Data, Augmented Reality, Virtual Reality.

Vision and methodological approach

The challenge of digitization that the construction industry is facing is absolutely an opportunity to be seized, but at the same time to be governed, in order to promote effective management of data over time. The *Building Information Modelling* (BIM) methodology, strengthened by the pervasive use of new technologies, represents the new frontier for organizing, exchanging and displaying a large amount of information on buildings, which thus become the reference *Big Data* of built heritage. Thanks to technological innovation and the *Internet of Everythings* (IoT), data interconnection and availability are essential areas of research in the digital age, as they involve various disciplines, even very different from each other, with different levels of maturity. Through the parametric digital models it is possible to arrange all the necessary information about the buildings in a unitary and congruent way, storing datasets that, within an integrated process, can be interrogated with a different level of detail according to the type of user and at the scale of interest. The BIM tools promote the census of buildings, related assets, systems and structural elements, complete with alphanumeric information, as well as geometric, and from external data sources such as photographs, videos, technical data sheets. In this way a real identity card of the building is created, able to evaluate the docu ment status and inefficiencies of the system during its entire life cycle. The vision of the Cadastre of the Future has matured in this context. It is interpreted as a methodological system for

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managing information on the built heritage that aims at completeness and usability of data thanks to the typical tools of BIM, not only for tax purposes but also and above all for conservation, management and maintenance at building and urban level. It is not only a matter of storing documents already available, but of setting and planning methods of investigation, in-depth analysis, research and evaluations that can provide a cognitive framework of the built heritage through a rigorous process set up during the start-up phase. This process must then be implemented with data that can be continuously collected over time, with successive and different levels of detail related to different interventions on the building. In this scenario, more than ever, it is worth the concept that those who start well are half of the work and, of course, that if you do not start, you will never reach a result of adequate quality. Waiting to have all the necessary information, would mean continuing to work according to the traditional approach, that is, without a true knowledge of the built knowledge. In this perspective, the involvement of public administrations is undoubtedly essential. Even if with different reaction times, in recent years we have witnessed a growing interest and involvement of public administrations in innovative processes, also through experiences related to European planning, especially focusing on issues related to energy saving, and the dematerialization of information, so as required by the Prime Ministerial Decree 13/11/2014.

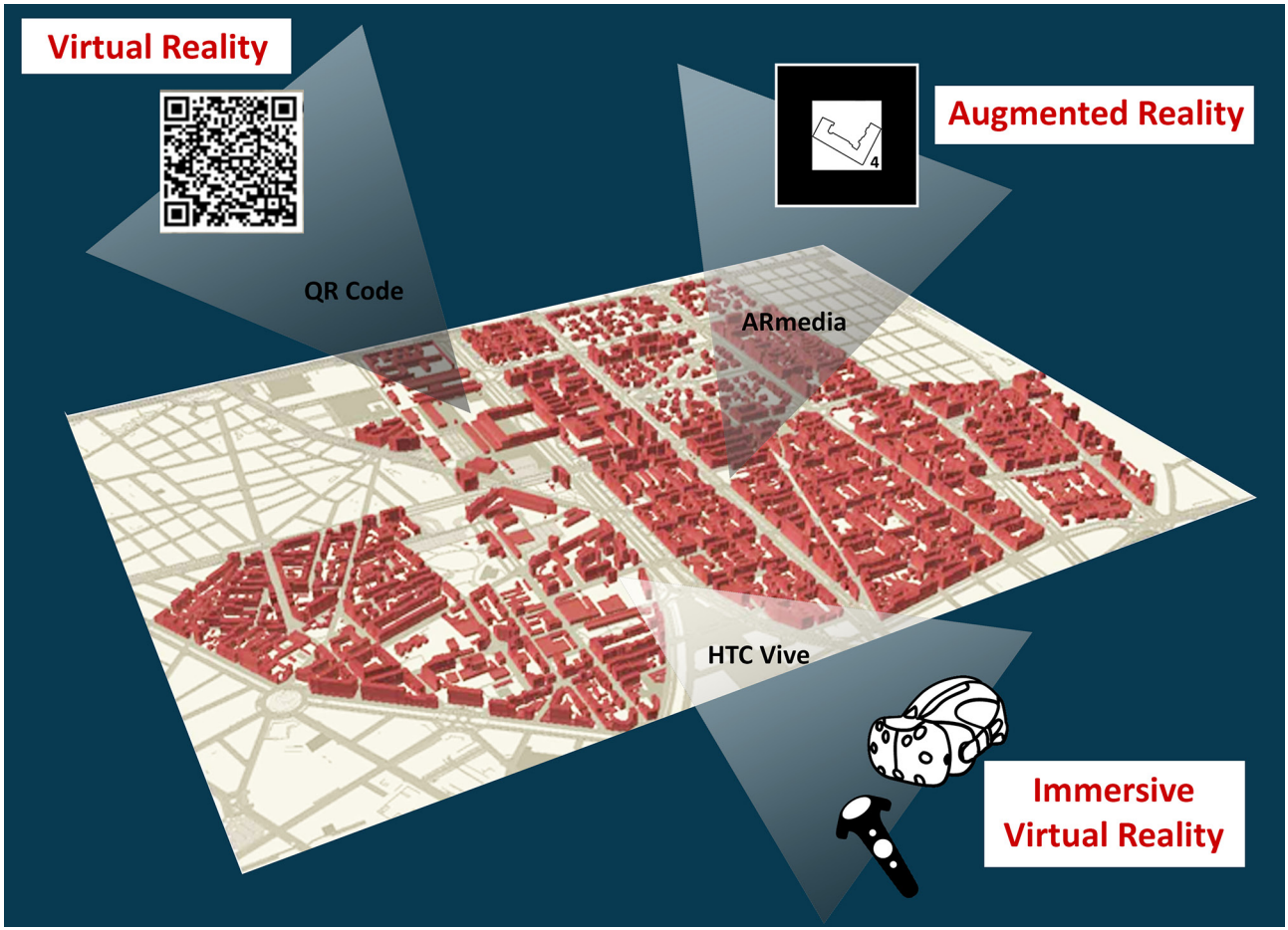
Case study

Preliminary experimentation towards this type of integrated research has been carried out by taking the City of Turin as a case study, putting experiences of data communication conducted within the *District Information Modeling and Management for Energy Reduction* (DIMMER) European project, focused on energy saving at the district scale, and the BIM digitalization of public buildings of the city (ToBIM) into system.
In DIMMER, whose demonstrators were Turin and Manchester [1], the main objective was the implementation of a middleware platform in which geometric and alphanumeric data coming from different domains were integrated *BIM, Geographic Information System* (GIS), *System Information Model* (SIM), IoT. The *District Information Model* (DIM) concept was introduced for the first time. The added value of this type of integration lies in the possibility of inter-exchanging data between the various stakeholders typically called to operate on both the construction scale, such as facility managers, and the urban one, such as energy managers/providers. This information, available through various systems with a web interface, such as platforms and dashboards, is aimed at improving the awareness and collaboration of different types of users on energy efficiency. The visualization of data is also explored through immersive and augmented virtual reality systems, in order to test new communication possibilities (fig. 1). Furthermore, a gamification approach has been adopted to make young people an active part of the awareness process on energy issues.
ToBIM [Osello, Ugliotti 2017] on the other hand, analyzes the most representative public buildings of the City of Turin at a construction level through an investigation process aimed at identifying the basic information necessary to guarantee management and energy monitoring activities in the context of a diversified and extended property portfolio. Re-establishing the knowledge of the artifacts is the setting up of information between the various actors to guarantee the effectiveness of the process, and therefore the analysis and comparison of the data acquired through the BIM modeling (fig. 2).
These experiences led to the creation of an interactive map, described below, which presents a cross section of the city of Turin to be explored through Augmented (AR) and Virtual Reality (VR), as enabling technologies in the communication process.
The main objective is to bring citizens, as well as operators, closer to a new, more reliable and accessible information management approach for buildings and the city, based on a process of intelligent digitization of the built heritage starting from the BIM method.

Cognitive survey preparatory to the definition of the BIM contents in the perspective of the Cadastre of the Future

Searching and analyzing existing information related to buildings is the first step in digitalizing built heritage. Starting from the experiences carried out in the aforementioned projects, it has been proved that information management is lacking in procedures and tools that guarantee their uniqueness and reliability. In fact, often *As-Built* documentation is paper-based or not updated and more digital versions are available, as well as the fact that the informa-

Fig. 1. DIMMER: investigation on urban scale visualization mode (graphic eleboration by the authors).



tion characterizing the building envelope or inventory of components is completely lost over time. Extending the analysis to the entire building process, it is evident that the most significant problem that afflicts the construction industry is the lack of information during the life cycle of buildings. The accuracy and completeness of the knowledge of the artefact is a key factor that profoundly influences subsequent investigative activities [Simeone et al. 2014]. In fact, any planning or maintenance intervention is based on what is known of that object. The scarce availability of resources, time and money, to find adequate information involves evaluating interventions based on assumptions that may lead to operating problems and consequent cost increases. The lack of data, or the exchange of information from one stage of the process to another and from one subject to another, represents a cost, which was quantified for the first time for this sector in December 2004 by the *National Institute of Standards and Technology* (NIST) [2] at $ 15.8 billion, of which two thirds are attributed to the *Operations & Maintenance* phase [NIST 2004]. Starting from this critical situation, the BIM can on the one hand constitute the instrument that becomes an integral part not only of the design and construction but also of the management of the building, on the other the method of data exchange between the various subjects involved, limiting the dispersion of information and the resulting costs. The digitalization activities of the building heritage must therefore be conducted in such a way as to guarantee knowledge, organization, sharing and usability of the information, which become the key to the success of this type of initiative. The modelling activity is aimed at returning a representation of the actual state of the buildings, where the added value is configured in the possibility of populating the database with information of interest for different types of users, from the citizen to the building manager, from the energy manager up to the city planner. At building level, the aspects considered mainly refer to the functional decomposition of the building, explaining typological and quantitative information regarding the composition of the envelope (opaque and transparent surface, materials), spaces and equipment, and technological systems. Parametric models must be set up in such a way as to provide significant information in real time under ordinary management and maintenance, but even more so in emergency conditions to design correct architectural, structural interventions and systems operations. The potential lies in the fact of being able to investigate the buildings not only as a function of what is visible, but above all of what is not. This aspect is particularly significant for the planning of ordinary and extraordinary maintenance of technological systems and for verification of structural or seismic stability. Consider, for example, the great advantages in case of seismic, alluvial, or fire events, in being able to have virtual models accessible by professionals in which to quickly find reliable information and technical data on the building. It is essential then to relate these data on the one hand with the intended use, occupation and usage profile of buildings, on the other with the urban/district context in which they are located. The data must be cross-examined in order to refine the level of detail of the surveys and assessments, promote more realistic optimization scenarios according to the actual characteristics of the site. It is very different, in fact, to compare the high energy consumption of a building, in consideration of its extension (e.g. one level or high vertical development), of the specific function (e.g. school or police headquarters), of the opening period (e.g. limited opening or H24), of the types of lighting devices present (e.g. dated or last generation), and of the possible presence of specific equipment (e.g. computers or laboratories), compared to not having any reference information. Furthermore, the planning of any efficiency enhancement measures must be the result of a careful evaluation of the cost-opportunity balancing, ie technological-plant engineering solutions actually applicable also in consideration of the structural and use capacities.

Also in *Smart City* perspective, it is very important to know the real situation of the heritage, in consideration of the activities of territorial planning, management and energy efficiency, therefore the information collected on a building scale must necessarily be correlated with the urban territory. BIM offers a broader perspective to analyze the heritage of the city, promoting tools for asset management that can be integrated with GIS systems in order to enrich spatial information with those on individual buildings. This, currently in the phase of experimentation and research, would allow an efficient and effective management of the facilities at the district/city scale, evaluating not refurbishment operations but also optimizations of systems networks and energy consumption. BIM data, combined with other datasets thanks to ICT, promote a dynamic cross-sectional vision of heritage. Building managers, thanks to these tools, could access real-time information on the building and its components, making accurate assessments of the operating conditions of the assets, allowing better usage.

Knowledge of built heritage must be brought back not only as a sum of individual buildings, but as a structured whole of buildings, facilities, infrastructures and all that constitutes a district/city. It is a matter of setting up a system of knowledge aimed at increasing safety, quality and optimization also in economic terms and maintenance planning.

The role of representation in the process of communicating information

To enrich the vision of the Cadastre of the Future, which queries Big Data for a better knowledge of the territory and the city, new solutions are experimented that combine representation with the needs of knowledge. In fact, it is noted that greater information and innovative and technological means of communication, including *Information and Communication Technology*, are required to have a substantial urban culture progress [Colletta, 2017]. This new communication setting enables a number of new possibilities to learn, plan, design, monitoring and creating strategies at the city level.
The central idea is to build an augmented digital city, which exploits the potential of the BIM methodology to establish a structured cognitive system of buildings, which can be integrated with other applications and dynamically interrogated through new communication technologies (fig. 3). This process involves the overlapping of digital content from a two-dimensional static representation aimed at increasing the perception of the built environment and the available information superimposing/replacing the reality. In this way, the link with information can be always

Fig. 2. ToBIM: Methodological setting of BIM models (graphic eleboration by the authors).

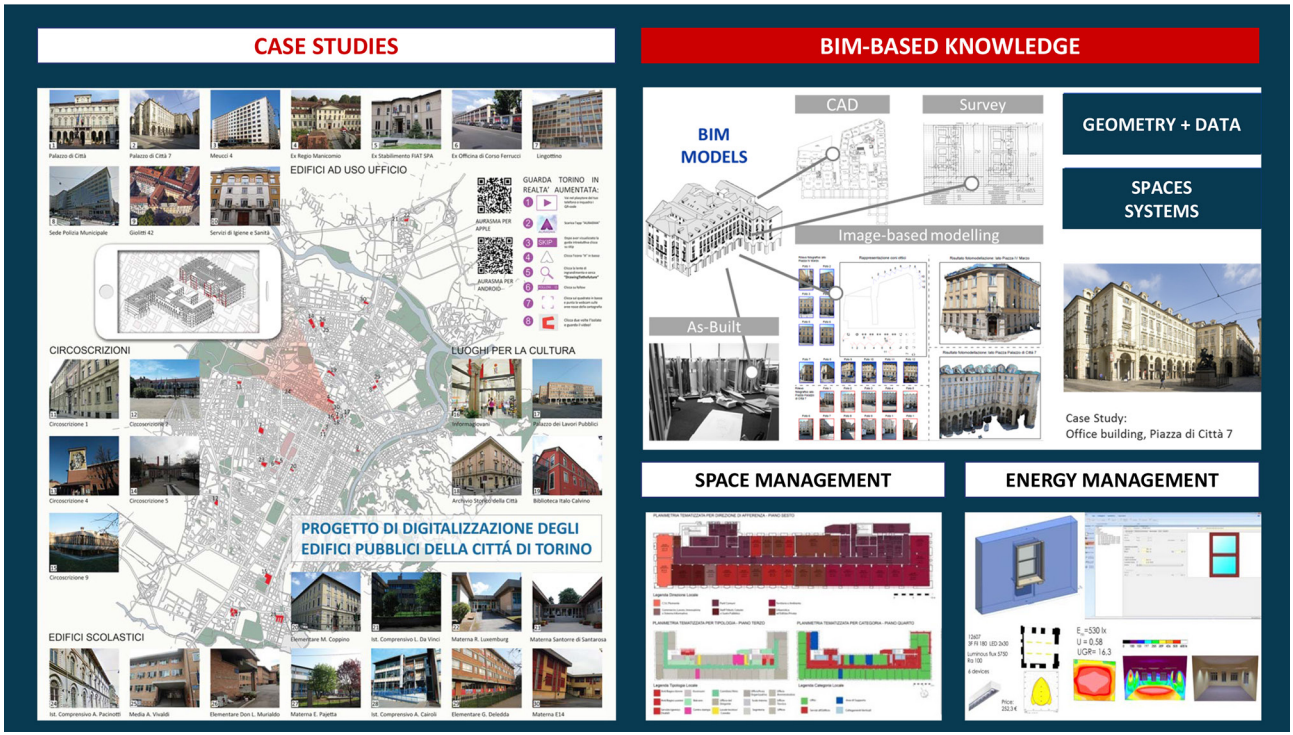
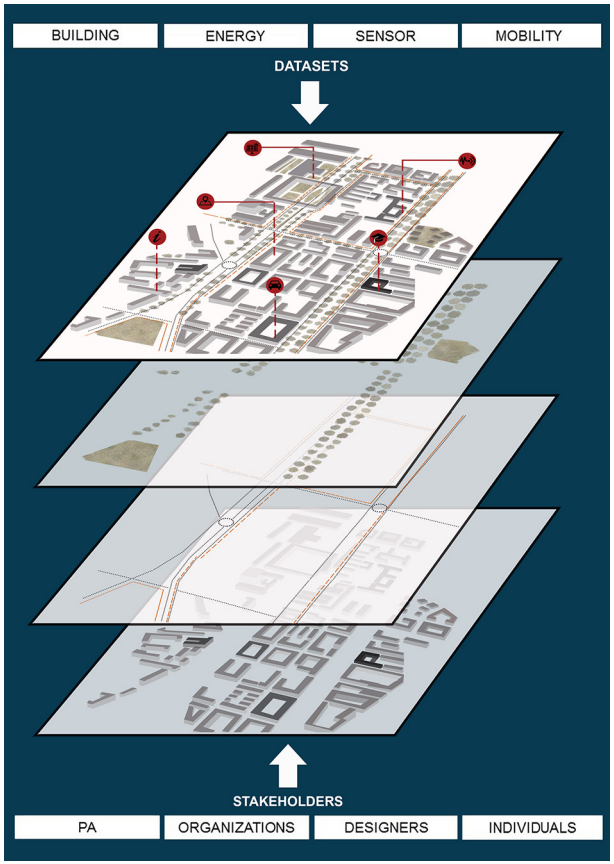


Fig. 3. Idea of augmented digital city (graphic eleboration by the authors).



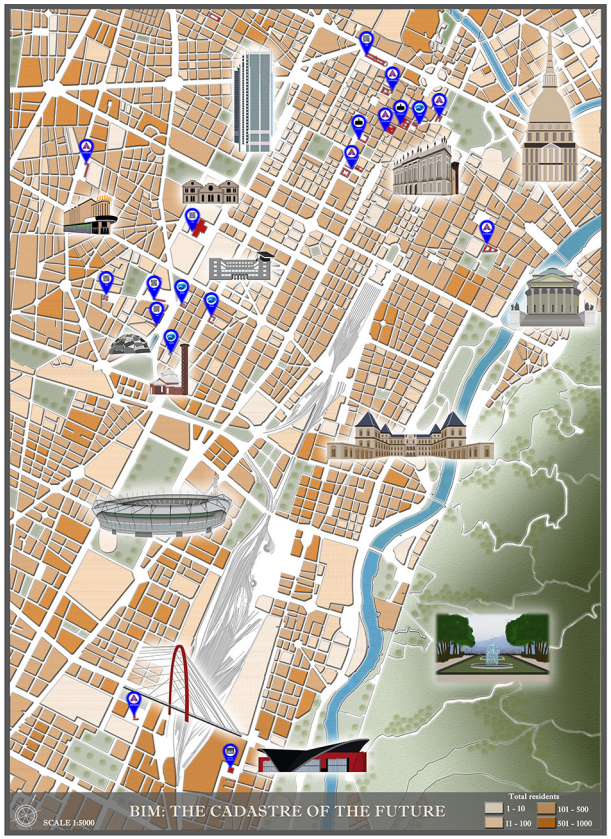
kept up to date, despite the graphical representation may be exceeded in the course of time. In this vision, many subjects (individuals, organizations, sensors, PA) can add digital informative layers in real time to the representation. Through the use of Augmented and Virtual Reality, it is possible to establish new modes of interaction that allow a greater number of users to access technical-information contents. It can therefore be said that the AR and VR combine to define a new model of augmented city in the era of *Smart Cities*, thanks to the use of objects that become speakers and provide access to information. AR begins to spread in the entertainment field, but, in reality, the focus is on infotainment that combines the quantity and quality of information to be used in a specific context with the simplicity of any capacitive surface associated with the use of a camera and a dedicated management system [3]. It is a visual content management 2.0 that adds new levels of information in real time and with high interaction rate using all types of mobile devices, including wearable technologies. Currently this type of communication is widely used in museum and tourist area, to make specific information available on certain objects/points of interest. The approach is participatory and links all the components of the supply chain, through tools and devices with which users are confronted daily even in private context. The traditional representation must now find the right balance with the digital evolution to extend the possibilities of dissemination of data. Sharing information and visualizing it in a simple and direct way is the enabling factor to fully exploit the potential of BIM, facilitating its use and display at different levels, from designers, operators and managers, from the building to the district and city. Actions aimed at increasing users' awareness exploit new technologies by promoting applications, interactive maps and virtual tours aimed at bringing citizens closer to a new approach to managing information about buildings and the city, based on a process of intelligent digitization of heritage built. Outlined the research objective, an interactive map of the City of Turin has been realized as preliminary application, which proposes a new system of representation and interrogation of the buildings starting from the technical cartography (fig. 4). The city map becomes, therefore, the large multimedia container where every entity that constitutes the built heritage is questionable, compared to the layer made up of the parametric digital models. For illustrative purposes, the map has also been proposed in large dimensions, through an installation of 52 sqm presented du-

ring Made Expo 2017. The user is directed to move freely in the space of the map by initiating a stimulating and at the same time unexpected cognitive experience between the buildings and the neighborhoods of the city. Places of historical interest are reported in order to guarantee orientation, while the focal points of interaction are clearly identified and define the type of digital content exploited. The principle is to create a series of touch points that act as a trigger to increase the perception of space. Several options for AR and VR visualization are offered in order to establish an interactive relationship with users.

Fig. 4. Turin BIM Interactive Map (graphic eleboration by the authors).

Making information usable through innovative technologies

The digital revolution, in all its ramifications, and the massive advent of innovative technologies, have generated a new organizational method, able to renew relationships and collaborations among the various stakeholders, focusing on new research and experimentation methodologies in the field of data integration and exchange, organized according to the information levels of which the intelligent city is composed.
In fact, new technologies can play a fundamental role in generating new synergies within the Real Estate sector, within an integrated process aimed at continuously enhancing and managing the property information involving public administrations, professionals and the private sector. Thanks to Augmented and Virtual Reality, in fact, it is possible to access more easily the information that defines the city and the built heritage. The use of these technologies facilitates communication, sharing and collaboration among different actors involved in different ways and at different times in the cognitive process (fig. 5). According to this approach, changes the way in which the city and the user can exchange information, through the definition of new rules and processes, in order to cooperate jointly towards the shared digitization of built heritage. The new technologies, in addition to ensuring greater accessibility of information, allow us to bring users closer to a greater awareness of the territory around them. For this purpose, three technologies have been analyzed in detail: AR, VR and 3D printing, to assess the degree of interaction with the user and identify the best solutions in the field of knowledge, dissemination, management and maintenance.
Through the Augmented Reality tools it is possible to increase the two-dimensional representation, by superimposing



digital contents, or information layers to a real scenario, by reading a marker using a smart device. There are numerous applications available in the market. Among these, the Aurasma application was used, which makes it possible to associate multimedia contents such as illustrative videos, drawings or websites/web platforms to an image such as the building's footprint. Framing the buildings represented on the map through the dedicated application, the user can view significant information of a specific building, facilitating the cognitive process involving the user in an interactive way. Specifically, considering the divulgative purpose addressed to the citizen, videos and descriptions which highlight the historical, architectural and functional characteristics of the buildings are recalled in the map. Similarly, QR Codes are used. They are experimented to connect information relating to systems, structural, compositional and historical features, as well as rendered stereoscopic views that allow a semi-immersion inside or outside buildings or parts of cities. Through the same procedure it is possible to recall specific technical, maintenance or management contents of interest to the individual categories of professionals. In this way, information is made available in the place and at the time when it is needed. Consider, for example, the relapse in the maintenance field, for which it provides the possibility to recall technical sheets of the components, maintenance procedures, or technical information on the field simply using a smart device. In addition, applications such as BIM viewers can be called up, allowing you to visualize even very complex and heavy models of buildings on mobile devices quickly, without the need for modeling software or being an expert in using them. The ability to access web viewers, such as Autodesk A360 viewer, allows you to start a real on-line query of information related to each individual object.

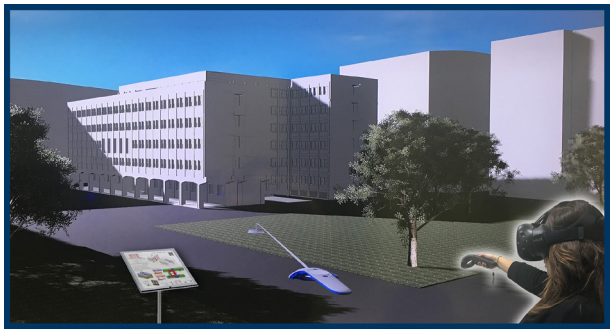
In addition to tools already available on the market, it is possible to create and customize specific applications, useful for managing and displaying detailed information for certain categories of users or professionals. In this way the knowledge of the individual building and the availability of data, facilitates the information process necessary to improve the relationship between user and building, as well as the maintenance and management of each indi-

Fig. 5. Technologies used in the Interactive BIM Map of Turin (graphic eleboration by the authors).

vidual building component. A very useful and interesting application to facilitate this cognitive process is the one experimented '*ad hoc*' for the Firman. In this case, the user through virtual joysticks on the screen of the mobile device, can move within the virtual environment and search for information of interest with respect to fire-fighting equipment, such as fire extinguishing equipment, or to safety procedures. The objects that can be interrogated can be identified by means of flashing devices that intensify the brightness as you approach it. It is possible to display different information depending on the user.
For example, the maintenance technician can access the procedures related to the testing or ordinary maintenance of the extinguishing means. The rescuer, on the other hand, may be interested in viewing the correct location of the means in the floor and their range of use. While the user working in the building can view emergency exits, safe places and assembly points to be reached in case of need. For its conformation, the app is useful during the training phase of rescuers and can be consulted on the way to reach the place of the intervention, so as to know the building beforehand and study the best intervention strategy. Thanks to Virtual Reality, on the other hand, it is possible to view three-dimensional high resolution environments and objects, with which the user can interact in real time, move freely through special devices, which guarantee a sensation of immersion and presence in the reconstructed environment. The tested applications concern the use of *Oculus Rift* and *HTC Vive*. The *Oculus Rift* allows a virtual immersion inside the single building and the possibility to interrogate the objects present. In addition to the classic navigation of the building, it is possible to superimpose information, functional, maintenance and logistic contents. In fact, thanks to this technology it is possible to visualize what in reality is hidden, such as the systems network and the structural part of the entire building or in correspondence with a specific equipment/component. It is possible to recall the related technical data sheets, energy documentation, technical details, or refer to maintenance procedures useful in case of inefficiencies In the case of historical buildings, the use of Virtual Reality, also allows to recall historical-artistic information, through documentation, audio or visual overlays. The use of the viewers allows you to take virtual tours, through which you can get in touch with a large amount of information. In addition to the *Oculus Rift* technology, the market offers new platforms for immersive visualization, not only for simple three-dimensional models, but also for BIM models with the relative geometric and alphanumeric properties of each building component. The *HTC Vive*, make it possible a total immersion of the user that can navigate within the city or a building, thanks to the predisposition of our virtual cognitive (fig. 6). Once the devices are worn, ie the viewer and the controllers, users can interact directly with the space around them and query the objects in the city, obtaining the necessary information (fig. 7). The technological innovation put in evidence, in addition to exploiting the potential of digital, provides new tools such as 3D printers able to faithfully reproduce the building virtually realized, in order to increase the visual and cognitive perception of the user. In this way, it is

Fig. 6. Alphanumeric properties visualization of the BIM model through Virtual Reality (graphic eleboration by the authors).

Fig. 7. Virtual city tour by HTC Vive (graphic eleboration by the authors).

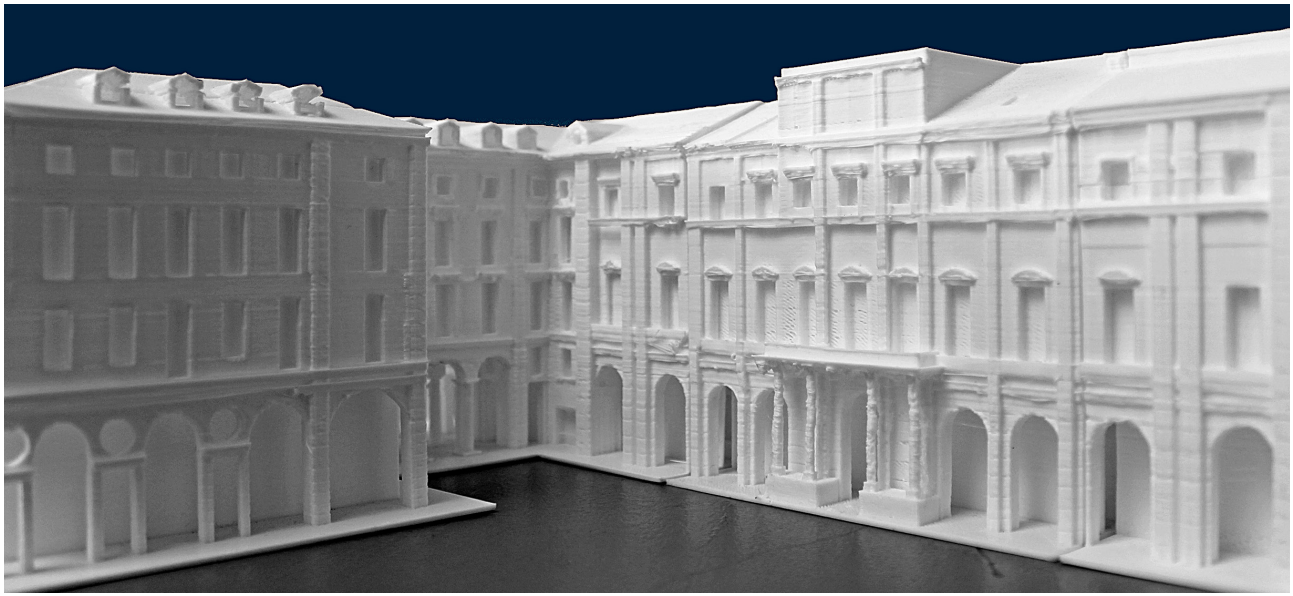


immediately possible to have a reference that is not only virtual but also real. Some of the most representative BIM models of the city, including the Town Hall (fig. 8), the new Unico headquarters of the Piedmont Region, have been reproduced through the 3D printer, providing further concrete and tangible reference points to the interactive map. They, although simplified in their geometry to facilitate the printing process, add new perspectives to the map, generating an additional information layer. The choice of including three-dimensional elements, further underlines how the digital revolution imposes a representation that immediately refers to reality and to simple yet effective communication tools.

Conclusions

It must be clear that, even if there is a cost in the digital re-organization of the data relating to buildings on a BIM basis, there is certainly a cost due to the dis-organization of the same and the procedures, tools and organizations that manage them. The ability to dream must allow us to go towards a Cadastre of the Future based on the BIM census of buildings and infrastructures that make up the city, dynamic, always updated and implemented over time. The task is not simple, especially as regards the level of reliability of the data, but it is still necessary to start with a precise program for the future. The BIM must be used to ensure the overcoming of the current difficulties in obtaining design, structural, systems and environmental information, with the aim of constantly updating the knowledge of the building and its essential components in order to allow the management of buildings based on integrated data and interoperable information systems. This digitalization operation must be thought of as an opportunity for rationalization and formalization of a process of knowledge and maintenance of built heritage. In this context, the case study of the City of Turin illustrated represents a virtuous beginning that must be implemented over time, not only to complete the digitalization of the city's heritage, but above all to make the BIM methodology, based on sharing of data that must always be updated, correct and certain. To build the Cadastre of the Future it is necessary to start a radical cultural change that involves the use of BIM models not

Fig. 8. Turin City Hall: 3D printed maquette of the BIM Model (graphic eleboration by the authors).



only as a simple three-dimensional graphic representation, but as a real alphanumeric database that must be used in an interoperable way among the different users. The tools currently on the market become the starting point for experimentation and for new reflections where the 'I' of 'Information' of BIM is the fulcrum of the debate to find effective solutions to be applied to the entire building supply chain. The digital revolution, made possible by the ongoing technological evolution, must become the opportunity for a true information revolution (fig. 9).

The authors shared the contents, critical analyses and operational practices of this research. In detail, Anna Osello was responsible for vision, methodological approach and description of the case study, Francesca M. Ugliotti for the preliminary studies for the definition of BIM contents for the Cadastre of the Future and for the role of representation in communication of gathered information (the latter with Daniela De Luca). Daniela De Luca studied how to use information by means of innovative technologies. The conclusions were collectively shared.

Notes

[1] Cfr. <http://www. dimmerproject.eu/public-deliverables/> (accessed 2018, March 18).

[2] <https://www.lagospm.com/03-benefits/articles/NIST.pdf> (accessed 2018, February 10).

[3] Cfr. <http://www.internet4things.it/smart-building/realta-aumentata-una-tecnologia-tantissime-applicazioni/> (accessed 2018, February 2018).

Fig. 9. The building heritage object of the digital and information revolution (graphic eleboration by the authors).

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Information Modeling Procedure to Represent a Territory Affected by Earthquake

Tommaso Empler

Abstract

ARIM (Assessment Reconstruction Information Modeling) procedure can be seen as the evolution and integration of the BIM systems used so far to monitor and document the transformations of the territory, such as HBIM, GeoBIM, LIM and SeismicBIM, representing at the same time their natural evolution for the management of prevention and reconstruction connected to natural disasters.
The application of the procedure is described on the case study of a building aggregate of Grisciano, a borough of the Municipality of Accumoli, describing the steps that constitute the part of the design/reconstruction of the BIM procedure, consisting of: cognitive framework, distinguished in 'direct knowledge' and 'deferred knowledge'; processing of the data collected; framework of the ARIM procedure, which provides a sub-articulation in data acquisition and their synthesis, finally the construction of the synthetic and informed 3D model.

Keywords: BIM, ARIM, 3D modeling, earthquake, VPL.

Introduction

Risks reduction deriving from natural disasters (DRR - Disaster Risk Reduction) and the building of settlements with resilient characteristics, have been discussed in several international symposia in recent years. Indications emerged in the "Sendai Framework for Disaster Risk Reduction 2015-2030" (last appointment in chronological order from this point of view), highlight the importance and role of a good planning to create less vulnerable and more resilient territories and communities, able to defend themselves against natural disasters and respond to environmental changes in progress.
The research [1] is based on the awareness that each earthquake has different impacts on cities and territories, based on a concomitance of factors that affect the specific characteristics of the earthquake, the territory involved, and also the socio-economic, cultural, institutional and administrative framework.
From this point of view, information systems (information modeling) can play a decisive role for a better knowledge and monitoring, a more effective management of both the built heritage and the territory as a whole, in a perspective in which prevention, management of emergency, recovery and post-earthquake reconstruction, sustainable urban regeneration of settlements, are thought not as separate but integrated actions.
President of the Italian Republic, Sergio Mattarella, on the occasion of the 20th anniversary of the earthquake that struck Umbria and Marche on 3rd of October 1997,

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issued a statement that goes precisely in this direction: "We need a general commitment to prevention. A kind of national pact. A pact for prevention that, overcoming political differences and oppositions, commits the entire country to prevention that would greatly reduce the risks and dangers of dramatic natural events and would allow to channel, into the normal life of our country, the solidarity that emerges with such force, passion and effectiveness on dramatic occasions" [2].
With this in mind, an information modeling procedure, called ARIM (Assessment Reconstruction Information Modeling), can be seen as the evolution and integration of the BIM systems used so far to monitor and document the transformations of the territory, such as HBIM, GeoBIM, LIM and the SeismicBIM, representing at the same time their natural evolution for the management of prevention and reconstruction connected to natural disasters.

Research methodology

ARIM procedure provides a flowchart, where the main variations, compared to a traditional BIM workflow, concern the part of the procedure linked to the 'design' sub-system, which can be interpreted as 'reconstruction design'. This is the part where the contribution of the disciplinary sector of representation and survey is central. As an example it is proposed the application to the earthquake that affected the Municipality of Accumoli in 2016.
The sub-system of 'reconstruction design' is organized as follows.
- Programming activities. Definition of reconstruction goals within an urban-spatial-territorial seismic approach (Accumoli and territorial context).
- Pre-earthquake cognitive framework, where sub-articulation includes: urban and territorial surveys, archive documentation, structural surveys, geological surveys, building survey, land reading. Urban and territorial surveys relate to the acquisition of the spatial planning framework and other planning documents (such as internal areas, etc.), emergency planning (Civil Protection Plan) and existing CLE (Limit Condition for the Emergency). The acquisition of archive documentation follows two different paths: institutional sources, where the existing cartography is available at various scales, collection of historical urban and territorial documentation (cartography, cadastre, historical photos, etc.), documentation on cultural heritage buildings; non-institutional sources, where the acquired material is related to private collections (photos, videos, historical prints, etc.). Structural surveys include the collection of existing studies on the vulnerability of strategic buildings, heritage sites, aggregates and infrastructures. Geological surveys foresee the collection of existing surveys on seismic microsomnia (MS), geological studies, hydrogeological layout plans. Building survey step provides a first distinction between 'fast survey' and 'detailed survey'. Data from the 'fast survey' comes from the web, the ones referring to 'detailed survey' comes from 3D laser scan or photomodeling campaigns. Collected data are organized for the achievement of a 3D model of the pre-earthquake situation. Territorial reading is an inquiry into socio-economic analysis, insights into specific built environments, the identification of aggregates and areas for specific insights, the history of urban and territorial transformations.
- Post- Earthquake cognitive framework defines the damage map, its sub-articulation includes: metric survey, geological investigations, urban and territorial investigations.
Survey step, foresees the same activities described for the step of the 'pre-earthquake cognitive framework', with the variant that the collected data are organized for the realization of a 3D model of the post-earthquake situation. Geological surveys include new seismic microzonations and the analysis of local seismic response. Urban and spatial surveys concern urban damage (physical damage, loss of functionality) in relation to a synthetic risk assessment of vulnerability, hazard and exposure.
- Reconstruction concept, whose sub-articulations are: urban and territorial proposals, geological proposals, structural proposals, architectural proposals.
- Reconstruction planning and prevention, are organized in: Urban and Territorial Proposals, Geological Proposals, Structural Proposals, Architectural Proposals.

Cognitive framework

In the knowledge of a territory one of the most relevant and innovative aspects is the risk prevention, which must be taken into account in several research areas,

ranging from the different stages of knowledge of the territory and urban centers (historical survey and metric survey of the physical reality), up to the direct application in the planning step of the interventions and the subsequent design.
In the definition of the cognitive framework it is foreseen a phase dedicated to knowledge and acquisition of data and information. In this step, we can identify two distinct levels of investigation of the studied territory and of all the inhabited centers related to it: 'direct knowledge' and 'deferred knowledge'.
Direct knowledge deals with the acquisition of information on the field, using both human resources (specialized and trained personnel for the purpose) and instrumental resources (3D Laser Scan, photogrammetric approaches, etc.).
The actions are organized according to gradual steps that follow a chronological order, and include at first the data detected at sight and recomposed in an overview and, in a second time, the instrumentation survey operations.
Direct knowledge of a site is focused at acquiring information of different nature, ranging from geometric dimensions of the settlements and their boroughs, relative relationships of proximity and scale, typological characteristics of the anthropized space, of individual buildings and their sets, hierarchies of routes to small and large scale. All these data are used to compile a series of thematic maps (possibly also supported by audio and video data) that are not just mental maps based on simple perceptions, but real supporting information tools to form a correct cognitive framework.
At the same time, 'deferred knowledge' is focused at collecting and setting up archive, bibliographic and cartographic sources (of a traditional type, but also of the open data type in digital format on the web), to be used for the drafting of thematic maps described above. By 'deferred knowledge' we mean in fact a complex of actions that can be carried out simultaneously with those of 'direct knowledge', but also at a certain temporal distance (before or after) from the collection of data on the field.
Following activities are connected to this stage.
- Historical-critical analysis: it involves the research of bibliographic and archival information related not only to the events of local cultures (as often done in the past in an exclusive way), but especially those related to the most significant transformations of the region and of the building object of the research, according to the identification of the relative constructive, typological and structural criticalities. These, in fact, have often left important traces in archives and libraries and maps of different nature, especially if linked to the past during previous catastrophic events.
- Acquisition of open source data: finding of web data, today easily accessible by different databases and often not considered to form a reliable cognitive framework (databases of previous damage managed by INGV, satellite images, technical and geographical maps of the IGM and CTR type, cadastral plans, shape files present in institutional regional sites, such as for example the Lazio Region electronic archive).
With reference to these aspects, both the current technical standards on constructions released in 2008/2009, and the Directive of the President of the Council of Ministers of 2011, for the safety of the historical architectural heritage from seismic risk, establish the obligation to perform accurate cognitive surveys of both historical-critical and geometric-dimensional nature, using all the documentation that can provide useful information to understand the constructive stratifications and the more or less catastrophic outcomes on the buildings of past events [3].

Web data for a deferred knowledge of landscape
Freely accessible web data provide a good contribution both from a technical-scientific point of view and to deepen and provide a first knowledge of the perceptive aspect of the place.
For example, the use of Google Maps, associated with the ability to download the navigable panoramas of Google Street View, allows a first step towards the knowledge of the plan and the state of conservation of sites, helping to identify significant elements and to accelerate the subsequent stages of knowledge on the site itself.
Regarding the use of GIS files present in the official sites of land authorities, their potential derives from the informative structure that characterizes them, therefore the ability to collect simple primitives (points, lines and surfaces) associated with metadata. The metric reliability of the information collected in the files makes it possible to make initial formal considerations, but also attempts to represent urban models and the terrain on which they are based. A first experience was conducted on the representation of Accumoli and some fractions of which it is the capital, with particular reference to the borough of Grisciano (fig. 1).

In general, it is productive, to complete the framework of knowledge, to cross historical information obtained through consultation of archival documents (texts, cards, etc.), with web information obtained from the consultation of websites, Facebook pages, blogs and videos, able to give a more direct and personal reading (YouTube, fractions Facebook page, etc.).

Tools for direct knowledge
Survey operations provide the integration of different tools and methodologies, in order to have overlapping and verifiable data, which can cover the gaps that each instrumentation can present in different environmental situations. Instrumental surveying method foresees: data acquisition by means of 3D laser scanners; data acquisition for Structure from Motion (SFM); the acquisition by drone of the roofs of buildings and of all surfaces not detectable from a ground view. It is also possible to add to survey project data acquisition through a motorized panoramic head, both for spherical panoramas and flat or rectilinear panoramas.
In the acquisition of data by 3D laser scanners, scans are captured both by Leica C10 Scanstation and Faro Focus 3D (fig. 2).
SFM techniques or, more precisely, automatic digital photogrammetry, is a methodology that allows us to create a three-dimensional model starting from a large dataset of two-dimensional images. It is a set of techniques and technologies that fall within the field of Compurer Vision research and derive from the evolution of traditional photogrammetry (science that deals with extracting metric information from photographs). Whereas traditional photogrammetry involves manual intervention, in which the presence of an operator is required to process the images, the automatic one uses a digitalized procedure exploiting procedural algorithms.
Drone survey provides the acquisition of digital images, prepared on the basis of a careful calculation and according to the final scale required. There can be arranged a series of flights, with altitudes between 30 and 50 meters, bearing in mind that the higher the altitude increases the more decreases the resolution of the photos and the consequent level of detail of the cloud of points, therefore, it is desirable to have a good resolution of the final point cloud (lower 5 cm/pixel).
Data acquisition by means of a Clauss HD motorized panoramic head, allows to shoot a 360° subject. The sequence of images with which pin the spherical support of the representation takes place with a step-by-step confirmation, controlled by a special software that automatically manages the acquisition sequences,

Fig. 1. Municipality of Accumoli, borough of Grisciano after the removal of earthquake ruins.

Fig. 2. 3D acquisition of the borough of Grisciano with a Laser Scanner Faro Focus 3D (image by Leonardo Paris).

Fig. 3. Data acquisition with thermal imaging camera.

according to the set program. In particular, data can be collected to process spherical panoramas and rectilinear panoramas.
Data acquisition by thermal imaging camera (fig. 3) returns colored maps that document the heat emitted by objects and how this spreads over the entire building. The camera, working in the infrared wavelengths, represents variations through characteristic color ranges that describe certain behaviors of materials and structures.

Collected data processing

The spatial model (3D modeling of land morphology) is generated by using visual programming language (VPL) that allows to relate both the geometries and the attributes obtained by the acquisition processes foreseen in the direct and deferred mode.
Thanks to the VPL process, it is possible to merge data from different shape files into a single model for the 3D representation of the territory. Two models can be developed: a mathematical one (NURBS) obtained by the VPL programming of the traditional 3D building processes of simple models (projection and extrusion of geometries); then a numerical one (mesh) through the triangulation of points arranged at the correct altitude.

ARIM procedure framework

Assessment Reconstruction Information Modeling procedure (ARIM) framework (fig. 4) shows a stage of 'data acquisition', a 'synthesis phase' and a 'modeling' generation and management phase.

Data acquisition and their synthesis
As previously said, data acquisition can take place, with 'delayed' mode, with 'direct' mode and use of external metadata. In the first case we deal with web data, consisting of vectors and metadata available in the network; in the second case, a point cloud is generated by photomodeling, 3D laser scanning and topographic points; in the latter case, there are spreadsheets constructed specifically for encasing numerical and textual data related to different fields; these data, conveniently collected, can contribute to the construction of models.
Web data constituted by vectorial and/or editable nature are:
- shape files provided by the Regional Land, Urban Planning and Mobility of the Lazio Region, in vector format and provided with metadata concerning different properties of the represented buildings [4];
- data provided by the Copernicus website;

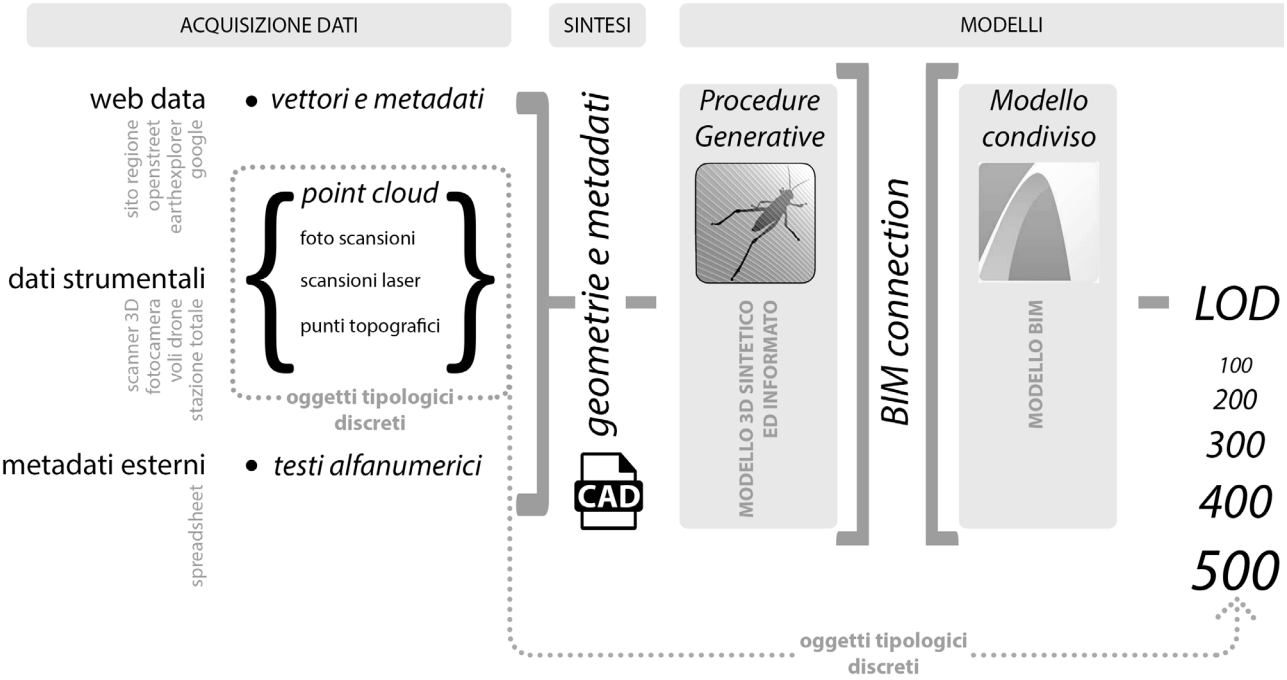


Fig. 4. Assessment Reconstruction Information Modeling procedure (ARIM) framework (image by Michele Calvano).

- data downloadable from the site www.OpenStreetMap.org (file .osm). It provides vector data associated with additional metadata of a numeric and textual nature (building height, number of floors, type of seismic failure, etc.). In web data management a visual computational procedure (Visual Programming Language or VPL system) has been used: different documents and data coming from the web are crossed and coordinated, such as, for example, the specialized site OpenStreetMap, whose information can be overlapped to the traditional maps of the territory (CTR - Regional Technical Map). Therefore, using, a procedure that foresees the download of the data related to the chosen area, the conversion of the native format (.osm) into a CAD format and finally the georeferencing of the downloaded data in a global coordinate system, it is possible to homogeneous data otherwise difficult to use. More accurately, the same procedure is applied to shape files, which, being technical sources, guarantees metadata and attributes collected with greater accuracy.

Downloading spherical panoramas of the areas covered by Street View it is possible to implement the image of the synthetic model.
Software used for the collection of photographic data from Google are on the web and freely downloadable (Street View Grabber and Street View Download 360). Downloaded data is an equirectangular image that shows the perspective aberrations typical of this projection.
Spherical images are subsequently used in a reverse return procedure compared to the shooting phase. The process is useful to give a photographic quality to the elevations of the synthetic 3D model and, at the same time, it allows the control of the measurements of the buildings. In this phase, a further research objective is set up [5], which envisages the creation of automated procedures that allow, starting from the spherical panoramas of Google in Street View, to construct the models represented in the equirectangular image that is being surfed.

Fig. 5. Photoplan of the 3D model taken from the point cloud (image by Leonardo Paris).

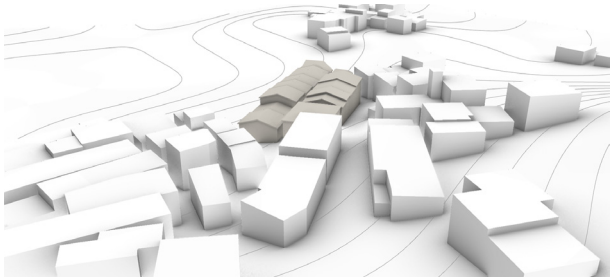
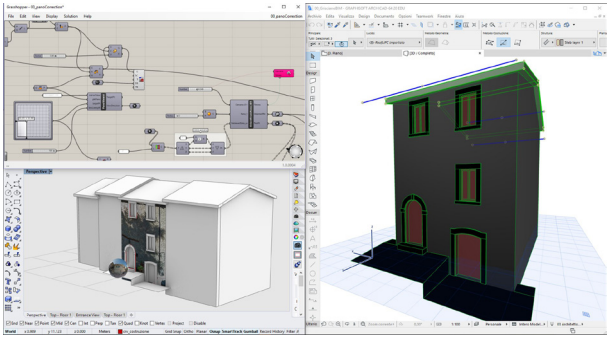


Fig. 6. 3D synthesis model of Grisciano: geometry and metadata (image by Valentina Adduci, Adriana Caldarone, Michele Calvano).

Once tested and perfected, the procedure will become, a plug-in that will be added to the VPL system described above. The value of this tool consists of the possibility of carrying out indirect surveys even in inaccessible places or in those places affected by unexpected natural events. A shift in scale takes place with the use of "instrumental data" coming from "detailed surveys", which refers to campaigns carried out with direct or instrumental surveying in the sites affected by the earthquake both before and after the disastrous event. Generally, the data consist of campaigns performed with 3D laser scanning, from the ground or from drone, or with photomodelling campaigns.
Point clouds taken from the above described activities are processed with specific softwares (such as Cyclone, Recap, Scene, etc.) (fig. 5), which allow the subsequent passage in mathematical and numerical modelers, as seen for the VPL procedure.
Data collected with the 'deferred survey' and the 'detail survey' are organized in a three-dimensional 'synthesis model' (fig. 6), after having undergone a process of decimation and selection of the significant elements. The obtained result is a synthetic 3D model (polyhedra that summarizes the boundaries of each building and the related roofs) informed by the individual metadata [6]. A sort of three-dimensional GIS model with greater communication and interactive capabilities.

Construction of the synthetic and informed 3D model
In the case of Accumoli, the 3D modeling software used is Rhinoceros + Grasshopper [7] (fig. 7), which allows the management of generative procedures, in which a synthetic geometric model is returned by interpolating the data coming from the regional technical map, .osm data, orthophotos, panoramas from google, data obtained with point clouds detection. The result is a simplified NURBS model that shows, according to the measure, the ground, the consistency of the buildings and the roofs of a urban settlement, of the hamlet of Grisciano. Thanks to a Grasshopper plug-in (Gh-AC connection), the synthetic geometric model is linked tothe Archicad parametric environment (shared model). This is the best application for model information, where geometric parts become architectural objects, enriched by several kinds of data.

ARIM procedure applied to Grisciano
Below we describe the workflow carried out to generate the ARIM procedure for an urban context such as Grisciano, completely demolished after the earthquake (direct demolition due to the earthquake and subsequent controlled demolition for the safety of the area). In Grisciano area are available photographs, point clouds obtained with 3D laser scanners and GIS maps. 3D tool used in the procedure is Rhinoceros software, which allows to view the operations programmed in Grasshopper. Grasshopper is a Visual Programming Language (VPL); useful to create a synthetic model by relating geometries and metadata, even of a non-homogeneous nature. The goal is the creation of an ARIM system able to memorize both the form and the data of the pre-earthquake urban space. To do that, we have used Archicad, a Graphisoft BIM software, which today, thanks to the add-on Archicad-Grasshopper Live Connection, allows Archicad to use the capabilites of programming in VPL.



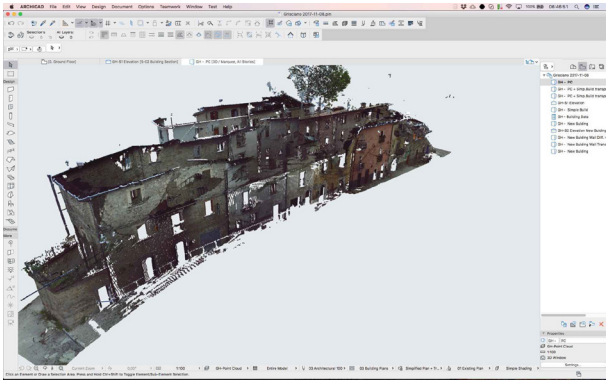
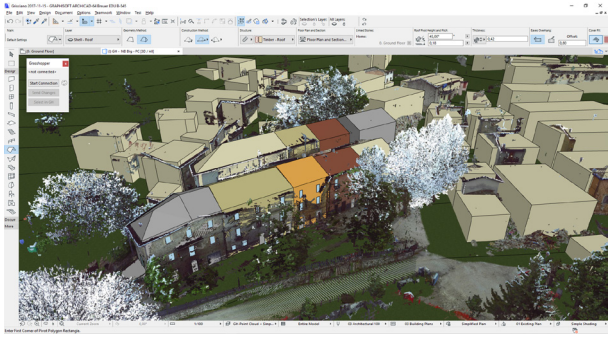


Fig.7. 3D reconstruction of a housing block of Grisciano with the Rhinoceros + Grasshopper procedure (image by Michele Calvano).

Fig. 8. Overlap and orientation of the point cloud, obtained from the laser scan survey carried in Grisciano's housing block (image by Michele Calvano).



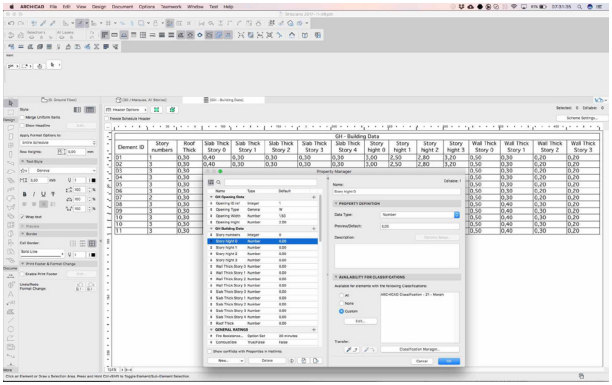


Fig. 9. Construction in a BIM environment of 'synthetic volumes' adhering to the actual dimensions of the buildings (image by Michele Calvano).

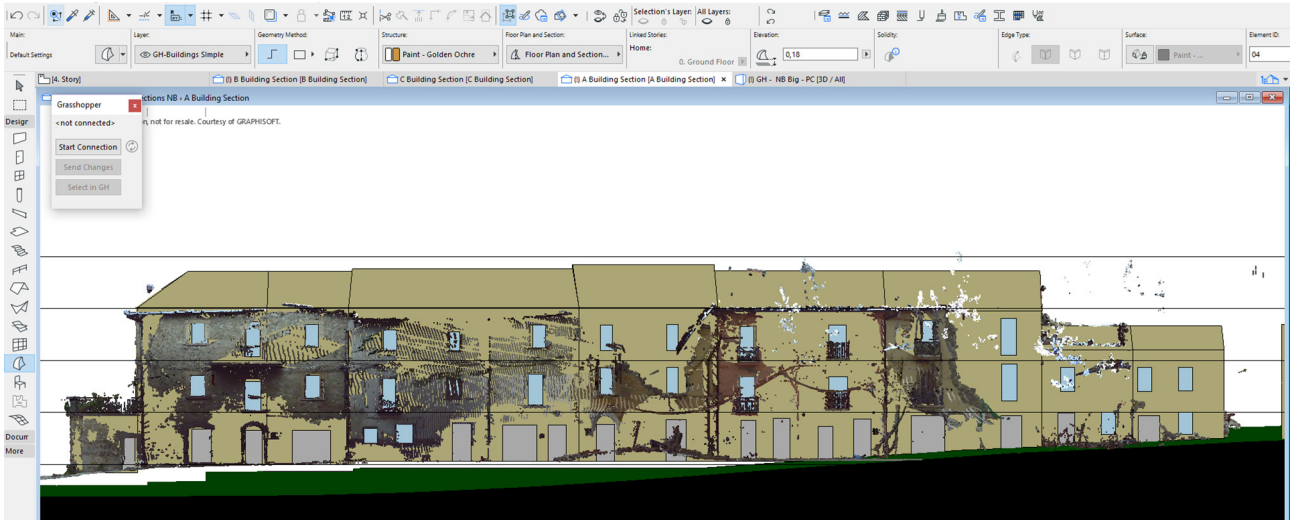
Fig. 10. Synthetic volumes created in BIM environment are equipped with additional parameters (metadata) that describe, through alphanumeric data, some intrinsic characteristics of each building (image by Michele Calvano).

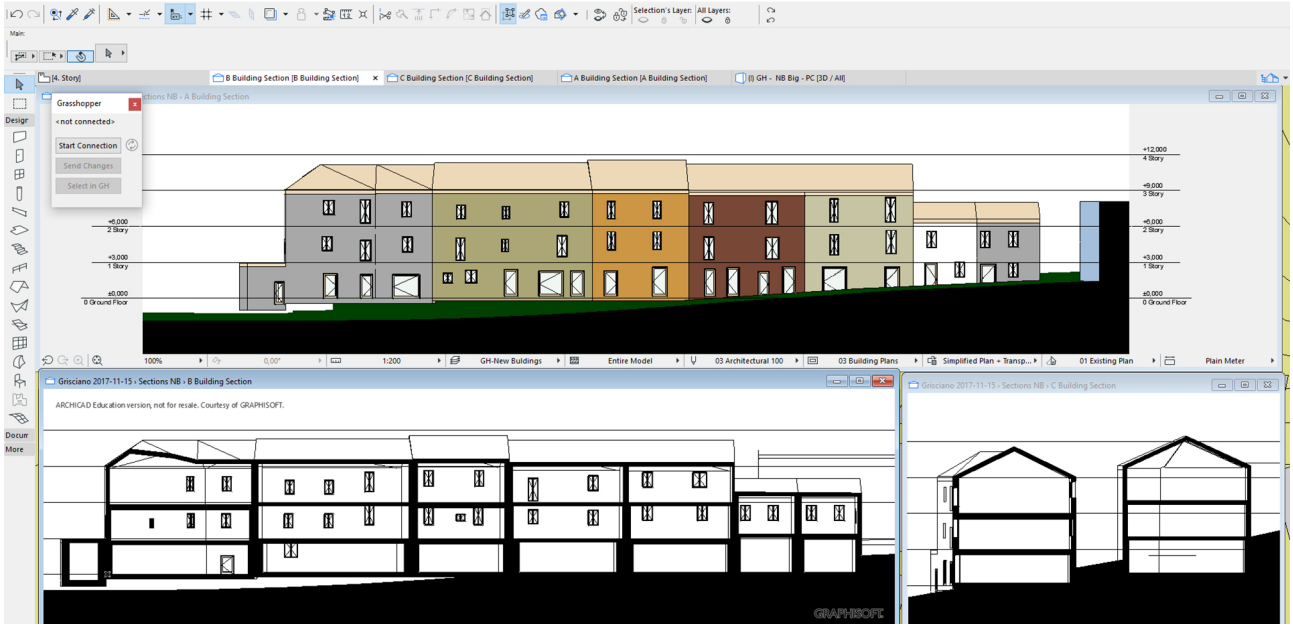
Main steps of the workflow are:
- External GIS data (retrieved from the network in specialized sites) that are used for the generation of the ground of the borough affected by the earthquake and the development of the volumes that make up the urban structure. This first step has been carried out with a conceptual modeler, where the synthetic geometries that describe the urban spaces with 'synthetic volumes' are modeled with an accuracy equal to a scale of representation 1:5000. Both the volumes and the terrain have been generated by an automatic 3D construction process using the VPL approach.

- Through the use of specific components, it is possible to import the conceptual geometries generated with the programming system in BIM environment. This step refers to the translation into the BIM modeler of the ground and of the 'synthetic volumes' previously modeled with the aid of VPL.
- In step 3 the overlap and orientation of the point cloud is carried out, obtained by the scan of the borough (fig. 8); this operation is useful for the construction of 'synthetic volumes' in the BIM environment more closely related to the actual dimensions of the studied buildings (fig. 9). Point clouds survey allows a leap of scale (similar to 1:50) in the reconstruction of the buildings, initially rebuilt with

Fig. 11. Point cloud model allows to view the shape of the windows and their position along the surface of the walls (image by Michele Calvano).

Fig. 12. Programming in VPL and connection with the modular architectural objects in BIM environment (image by Michele Calvano).





only GIS data. Points cloud model must be able to represent, through the numerical model, an exhaustive condition, from which it is possible to deduce the real model to be interpolated with continuous surfaces.
- Synthetic volumes created in the BIM environment are equipped with additional parameters (metadata) that describe, through alphanumeric data, thanks to the direct or visible survey, some intrinsic features of each building. Among the memorized properties we mention the number of floors, the thickness of the walls and floors, the roof type and the, building materials (fig. 10). Point cloud model allows to view the shape of the windows and their position along the surface of the walls. Also in this case the holes can be interpreted with plans that synthesize the shape and the position. Rectangular vertical planes that overlap with window images (fig. 11). Also to these geometries can be attributed alphanumeric properties, thanks to the on-site observation and the direct survey, for the typological description of the frames.
- Through the programming in VPL and the connection with the modular architectural objects in the BIM environment, the synthetic geometry of the volumes and the doors and windows are deconstructed, associating the dimensional data and the metadata previously attributed to the architectural objects, which, in this way, are recomposed in an informed architectural model, able to describe in detail the buildings partially destroyed by the earthquake (figs. 7-12).

Conclusions

Validity and potentiality of the ARIM procedure, in the BIM environment, is recognized by the Graphisoft company, that is working to increase the flexibility of BIM modeler Archicad, in order to communicate directly, to create and manipulate a complete or partial BIM model, through the interface of visual scripting of Rhino/Grasshopper [8].
New scenarios are opened in the field of 3D modeling; and, BIM representation: parametric modelers are able to acquire, manage and manipulate shapes deriving from objects that no longer possess, due to a natural disaster, any form generable or editable directly with traditional geometric tools.
The research has now the goal to identify an automatic procedure for defining discrete typological objects (fig. 4), deriving from a complex reality, at different levels of detail (LOD).

Notes

[1] The author is the coordinator of the Research Unit 'Urban Seismic Risk: prevention and reconstruction', established in 2017 by the Department of History, Representation and Restoration in Architecture - Sapienza University of Rome. The RU presents a working group of 30 people, interdisciplinary and interdepartmental. This article is the first issue of the research program, of which the author is the principal investigator, funded by Sapienza University of Rome and titled 'Urban/territorial restoration and seismic risk prevention: a methodology. Learning and experimenting from the case of 2016 Central Italy earthquake'.

[2] <http://www.ilsole24ore.com/art/notizie/2017-10-03/terremoto-mattarella-serve-patto-nazionale-la-prevenzione--140309.shtml?uuid=AEJHfvdC&refresh_ce=1> (accessed 2017, December 27).

[3] New Technical Standards for Construction (Decree of the Minister of Infrastructures dated January 14, 2008, G.U. No. 29 of February 4th, 2008, No. 30).

[4] <http://dati.lazio.it/catalog/it/dataset?category=Territorio+e+urbanistica> (accessed 2017, December 27).

[5] This part of the research is developed by Michele Calvano, Andrea Casale and Leonardo Paris, Department of History, Representation and Restoration in Architecture - Sapienza University of Rome.

[6] Part of the procedure was used in the 'Instant Modeling' operation conducted for Amatrice (Francesca Guadagnoli and Michele Calvano) which led to an efficient and accurate 3D modeling operation, which returned 'what is not there more' and gave back 'a form to absence'.

[7] This part of the research is still ongoing and is conducted by Michele Calvano and Mario Sacco with the Graphisoft software house, as an implementation of Archicad.

[8] <https://architosh.com/2017/12/graphisoft-dramatically-reshaping-the-power-of-bim-the-new-rga-live-connection-2-0/> (accessed 2017, December 30).

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Readings/Rereadings

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The Work of Art in the Age of Mechanical Reproduction by Walter Benjamin

Alberto Sdegno

More than eighty years after the first draft of *Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit* [1] by Walter Benjamin [2], the reflections and discussions on the theme of the original, the copy, and reproduction are so relevant today that it is difficult not to recognize the primacy of the German intellectual for having effectively posed some terms of the question. It should be said immediately, however, that the famous essay on *The Work of Art* did not have a linear and definitive drafting. There are, in fact, five versions of the text [3], four in German and one, coeval, published in French, albeit with cuts and revisions not approved by the author. To briefly summarize the history of the important contribution, it can be recalled that its writing began at the end of 1935 and continued up to the last draft of 1939. The only publication during the author's lifetime took place in the month of May following the first draft, in the Frankfurt School's *Zeitschrift für Sozialforschung, in the French translation by Pierre Klossowski* [Benjamin 1936]. In some letters written by Benjamin between February and March 1936 [4] to Max Horkheimer –editor of the journal– the criticisms of the editorial changes and omissions –the "erasures done *behind my back*" [5], as Benjamin wrote– are documented substantially due to political opportunities, which were followed by a correspondence [6] also involving the journalists Hans Klaus Brill and Raymond Aron. The essay was published in book form in 1955 [Benjamin 1955]: this was used as the basis for the first Italian translation, published in the following decade [Benjamin 1966].

To understand the objectives that Benjamin pursued during the writing process, it is sufficient to read what the author wrote to Horkheimer on October 16, 1935: "For us, the fatal hour of art has struck and I have situated the point in a series of brief reflections dealing with the following title: *The Work of Art in the Age of Mechanical Reproduction*" [7]. With extraordinary clarity and expressive immediacy, the author addresses –in a short but content-laden essay– his reflections on the transformation of the work of art in the technological era. It should be remembered that the work saw the light of day after several of the author's own experiences and reflections of a similar consistency: as Antonio Somaini reminds us "in 1923 Benjamin, along with Moholy-Nagy, belonged to the circle of artists and intellectuals that gathered around the magazine 'G' (the first letter of *Gestaltung*, 'configuration'), directed by Hans Richter and strongly committed to the

Fig. 1. Cover of the first Italian edition of the book [Benjamin 1966].

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promotion of art forms characterized by a close association with technology" [Somaini 2012, p. 213]. There are also numerous works written by Benjamin before the one examined here with the intention of analyzing the changes that technology was bringing to the production of art: just think, for example, of the *Little History of Photography* of 1931 [8] and to *The Author as Producer of 1934* [9]. And we must also recognize that the period between the two world wars saw the flowering of contributions attentive to the role of the new media forms, many of which were well known to Benjamin himself. Suffice it to recall the book by László Moholy-Nagy comparing traditional and new figurative techniques [Moholy-Nagy 1925]; the essay by Vsevolod Illarionovich Pudovkin on film direction and writing [Pudovkin 1928] [10] and the work by Rudolpf Arnheim dedicated to cinema as an artistic form [Arnheim 1932] [11]. To these we could add various writings on the theme of the original and the copy, such as the essay by Erwin Panofsky entitled *Original und Faksimilereproduktion. Furthermor*e, this latter essay, published in the journal *Der Kreis* in 1930, from the beginning would suffer, for more than fifty years, a kind of *damnatio memoriae* [12]: it was not cited by subsequent studies, nor did Benjamin seem to be aware of its existence, even if it was antecedent to his essay, and in spite of the fact that some thematics of *The Work of Art* were already precisely delineated there.

There are many topics which the German intellectual found himself dealing with. The text, in fact, has been analyzed in the context of the political, philosophical, sociological, artistic and literary disciplines, including the history of photography, and is often referred to in essays of film criticism, since a large part of it is dedicated precisely to reflections on the novelties that cinema was introducing to involve the masses. Here we will omit all those aspects that do not regard the issues of our discipline, and we will try to highlight the parts related to general issues concerning mechanical reproduction and, in particular, drawing, also reflecting on the new aspects that digital instruments suggest to those who deal with representation.

The common thread that unites the different Sections lies in the epochal change that took place in the world of technology between the nineteenth and twentieth centuries, both for the reproduction of artistic works as well as for the production of new art, as is the case with cinematography. Great space is dedicated to the latter –in particular in the pages between Section VII and Section XI– even if cinema is also spoken of in other parts of the text. In extreme synthesis, the Sections that may be of interest to us are Section I, entitled *Technological Reproduction* [13]; those between Section II and Section V, dedicated to the problem of authenticity, of the aura and of the cultural value of the artistic work; Section XII and Section XV, which deal with the reception of art. There are many other parts, however, of great interest: where, for example, the author deals with the Dadaist experience (Section XIV) and in the previously mentioned Section XI, entitled *The Painter and the Cameraman*. The incipit of the volume leaves no doubt in the reader concerning the subjects that will be addressed [14]: "In principle the work of art has always been reproducible. What man has made, man has always been able to make again" [Benjamin 2008, p. 3], immediately specifying that reproduction in the past used techniques such as founding, casting, woodcut printing, engraving, etching, and, only in the nineteenth century, lithography. But photography, the author emphasizes, determined the difference: "since the eye perceives faster than the hand can draw" [Benjamin 2008, p. 4], with it "the process of pictorial reproduction was so enormously speeded up that it was able to keep pace with speech" [Benjamin 2008, p. 4]. Thus the principle was immediately established of the 'quickness' of the technologically recorded work, which differs from the 'slowness' of the hand that traces graphic lines. A quotation from Paul Valéry, present in the essay, strengthens this concept: "Just as water, gas, and electricity come to us from afar and enter our homes with almost no effort on our part, there serving our needs, so we shall be supplied with picture or sound sequences that, at the touch of a button, almost a wave of the hand, arrive and likewise depart" [15]. The profoundness of this phrase can be perceived in the thought of many intellectuals of the twentieth century. Think of Ernst Gombrich and Italo Calvino, for example, who would use similar words to translate the same concept: "We are living in a visual age. We are bombarded by pictures from morning to night" [Gombrich 1985, p. 155], the Austrian scholar said, and the Italian writer dealt with the theme of "visibility" in one of the lectures that were to be given at Harvard in the academic year 1985-1986, and published in 1988: "We are bombarded today –Calvino wrote– by such a quantity of images that we can no longer distinguish direct experience from what we have seen for a few seconds on television. The memory is littered with bits of pieces of images, like a rubbish dump" [Calvino 2002, p. 93]. Tomás Maldonado was to attenuate this concept, applying it in other contents: "Our society has been defined as a culture of images. We can accept this

definition, even if, on closer inspection, all cultures have been cultures of the image. This definition would be truer if we were to add that ours is a culture in which a particular type of image, the *trompe-l'oeil* image, reaches, thanks to the contribution of new production technologies and iconic diffusion, a prodigious veristic output" [Maldonado 1992, p. 48]. It is not difficult to find confirmation of all these annotations in current experiences; first and foremost, in the systematic iconographic communication that accompanies the owner of a smartphone at all times: the simple gesture that allows you to 'browse' images on the small screen and allows us to fully understand Valery's prophecy and the Benjaminian interpretation. Furthermore, the French author, in his essay entitled *The Conquest of Ubiquity*, expresses concepts on which Benjamin carefully reflected: "At first, no doubt, only the reproduction and transmission of works of art will be affected. It will be possible to send anywhere or to re-create anywhere a system of sensations, or more precisely a system of stimuli, provoked by some object or event in any given place. Works of art will acquire a kind of ubiquity" [Valéry 1996, p. 107], and adds: "I do not know whether a philosopher has ever dreamed of a company engaged in the home delivery of Sensory Reality. […] We are still far from having controlled visual phenomena to the same degree […] That will happen some day" [Valéry 1996, p. 108]. These considerations would be sufficient for understanding the great anticipatory plot unfolding within these sentences. We could highlight all the issues that –for some years now– the discipline of representation has had to deal with: from the digital cloning of an architectural or sculptural work, made possible thanks to the techniques of stereometric acquisition with laser instrumentation or with digital photomodeling, to the virtualization of reality, in the form of advanced real-time navigation systems with 3D viewers and datagloves; from remote digital modeling, to rapid prototyping and three-dimensional printing. A great novelty, then, was offered to the mind of Benjamin, which would lead him, in the following Sections, to reflect on the theme of authenticity, that is, the *hic et nunc*.

Starting from Section II, in fact, the German scholar approaches another fundamental question: "Even with the most perfect reproduction, *one thing* stands out: the here and now of the work of art – its unique existence in the place where it is at this moment" [Benjamin 2008, p. 5]. And he adds: "The here and now of the original constitute the abstract idea of its genuineness. […] T*he whole province of genuineness is beyond technological (and of course, not only technological) reproducibility*" [Benjamin 2008, pp. 5, 6]. The concept of authenticity, therefore, begins to be at the center of the observer's attention: "The genuineness of a thing is the quintessence of everything about it since its creation that can be handed down, from its material duration to the historical witness that it bears" [Benjamin 2008, p. 7]. The concept of 'aura' was actually dealt with in the brief historical essay on photography, where at one point Benjamin wondered: "What is aura, actually? A strange weave of space and time: the unique appearance or semblance of distance, no matter how close it may be. While at rest on a summer's noon, to trace a range of mountains on the horizon, or a branch that throws its shadow on the observer, until the moment or the hour become part of their appearance –this is what it means to breath the aura of those mountains, that branch. Now, to bring things *closer* to us, or rather to the masses, is just as passionate an inclination in our day as the overcoming of whatever is unique in every situation by means of its reproduction. Every day the need to possess the object in close-up in the form of a picture, or rather a copy, becomes more imperative. And the difference between the copy, which illustrated papers and newsreels keep in readiness, and the original picture is unmistakable. […] The peeling away of the object's shell, the destruction of the aura, is the signature of a perception whose sense for the sameness of things has grown to the point where even the singular, the unique, is divested of its uniqueness– by means of its reproduction" [Benjamin 2005, pp. 518, 519] adding that "uniqueness and duration are as intimately intertwined in the latter as are transience and reproducibility in the former" [Benjamin 2005, pp. 518, 519]. This long digression on the concept of 'aura', written years before *The Work of Art,* surely predisposes the author to consider the differences between the traditional artwork and the new artistic expressions. We could also try to apply this reflection in the idea of 'authorship'. In fact, this connotation surely comes into play if we talk about drawing, which binds the graphic sign to the hand that produced it, ie that of the draftsman. The drawing, especially if done in the form of a sketch, is 'autographic'. Its reproduction by hand, by another subject through a copy, in fact, immediately cancels the value of the copy, amplifying that of the original. The electronic duplication, on the contrary, thanks to the high quality achieved, while not being able to record the aura of the moment in which it was created by the subject, deceives its owner into thinking he possesses the original, as it allows him to scrutinize the most intimate details.

"[Photographic reproduction] is able to employ such techniques as enlargement or slow motion to capture images that are quite simply beyond natural optics" [Benjamin 2008, p. 6] continues Benjamin. In addition, another aspect is analyzed: "[technical reproduction] can also place the copy of the original in situations beyond the reach of the original itself. […] The cathedral quits its site to find a welcome in the studio of an art lover" [Benjamin 2008, p. 6]. This last reference –a true hyperbole, if considered in literal terms– is attenuated if we read it in the photographic context to which the author refers, but returns to being symptomatic if we interpret it with the tools of virtual reality that, indeed, allow us to don the guise of a singular *flâneur*, to use a term dear to Benjamin [Benjamin 2000] [16]. It is precisely the advanced 3D simulation tools, in fact, that allow carrying out the primary activity of the *flâneur*, described by the intellectual as one who "walks long and aimlessly through the streets […] like an ascetic animal [who] roams through unknown neighborhoods" [Benjamin 2000, p. 466]. The loss of spatial orientation, given by immersive technology, has something to do, from a certain point of view, precisely with the physical disorientation caused by the perceptive disorientation

Fig. 2. Walter Benjamin at the Bibliothèque Nationale de France, Paris, ca. 1933-1935. Photograph by Gisèle Freund.

of the citizen in urban chaos. At the end of the third Section –entitled *Destruction of Aura*– Benjamin paraphrases what was already written in the *Kleine Geschichte*: "Stripping the object of its sheath, shattering the aura, bear witness to a kind of perception where 'a sense of similarity in the world' is so highly developed that, through reproduction, it even mines similarity from what only happens once" [Benjamin 2008, p. 10] [17]. But besides the theme of the aura, as we have mentioned above, there are others of equal importance. In Section IV and, above all, Section V –entitled *Cult and Exhibition Value*– the important issue of the change of the experiential register of an art product is tackled. Benjamin is direct in recording analogies and differences in the temporal unfolding: "The oldest works of art, as we know, came into being in the service of a ritual – magical at first, then religious" [Benjamin 2008, pp. 10, 11], but "its being reproducible by technological means frees the work of art, for the first time in history, from its existence as a parasite upon ritual. The reproduced work of art is to an ever- increasing extent the reproduction of a work of art designed for reproducibility" [Benjamin 2008, pp. 11, 12]. As an example he offers the case of film-based reproduction: "From a photographic plate, for instance, many prints can be made; the question of the genuine print has no meaning" [Benjamin 2008, p. 12]. In Section V he is even more explicit: "Artistic production begins with images that serve cultic purposes". [Benjamin 2008, p. 12] and "Today this cultic value as such seems almost to insist that the work of art be kept concealed: certain god statues are accessible only to the priest in the *cella*" [Benjamin 2008, p. 12]. The display value of a work, we could state with an equation, is inversely proportional to the importance it assumes from the ritual point of view. A little further on he adds: "With the various methods of reproducing the work of art by technological means, this displayability increases so enormously that the quantitative shift between its two poles switches, as in primeval times, to become a qualitative change of nature" [Benjamin 2008, p. 13]. On these topics Massimo Cacciari proposes a meaningful reflection: "Benjamin insists, and rightly, –affirms the philosopher– on the fact that the work of art in the age of its reproducibility revolutionizes the very forms of its communication and perception. […] It is the problem of a 'subjectless' art, that is, an art that should represent the 'dynasty' of the Subject having reached its completion. This is the moment which, for Hegel, marks the "end of art" as such, and the beginning of something new. […] It is an art that abandons, paradoxically, in its very idea of genius, every immediacy" [Cacciari 2011, p. X]. The value of the artistic object being completely changed, Benjamin is even more direct when he deals with the issue of photographic production: "In photography, display value starts to drive cultic value back along the whole line" [Benjamin 2008, p. 14]. We could say the same of all the other forms of advanced communication, those that make use of more powerful figurative stratagems: from stereoscopic virtualization, to holograms, to mixed reality. In every case, the user is implicated in a different reality that often involves him completely without giving him time for reflection. We are facing, that is, what Maldonado called the phenomenon of "absolute iconization" [Maldonado 1992, p. 61], in which the subject concerned, abandoning the traditional practice of ritual, immerses himself in a new experience: "the modern (western) shaman dreams of being able to reach the state of trance without having to (personally) suffer the tribulations proper to initiatory practices" [Maldonado 1992, p. 54], and adds: "a state of trance that allows one to venture into the sacred without abandoning the delights of the profane" [Maldonado 1992, p. 54].

The umbilical cord of ritual being completely eliminated, it remains to be understood how –Benjamin wondered– the change in the reception of the work of art takes place. In Section XII he is quite explicit: "A painting always had an excellent claim to being looked at by one person or a small number" [Benjamin 2008, pp. 26, 27], but "The fact is, painting is not able to form the object of simultaneous reception by large numbers of people, as architecture has always been, as the epic once was, and as film is today" [Benjamin 2008, p. 27]. He goes more deeply into the matter in Section XV, where he recalls the concept of 'distraction', that is to say, of the approach to the work of art. "The person who stands in contemplation before a work of art immerses himself in it; he enters that work […] The distracted mass, on the other hand, absorbs the work of art into itself" [Benjamin 2008, p. 33]. Recalling the modes of perception of an architectural artifact, the author adds: "Architecture has always provided the prototype of a work of art that is received in a state of distraction and by the collective" [Benjamin 2008, p. 33], pausing to reflect on the fact that "the art of building has never lain fallow. Its history is longer than that of any other art, and imaginatively recalling its effect is important as regards any attempt to form a conclusion about how the masses relate to art" [Benjamin 2008, p. 34]. He then wondered about the ways of perceiving architecture: "Buildings are

received twofold: through how they are used and how they are perceived. Or to put it in a better way: in a tactile fashion and in an optical fashion […] Tactile reception does not occur both through the medium of attentiveness and at the same time through that of habit. […] Getting used to things is something even the distracted person can do. More: the ability to master certain tasks in a state of distraction is what proves that solving them has become a person's habit. Through the sort of distraction that art has to offer, a surreptitious check is kept on how far fresh tasks of apperception have become solvable". [Benjamin 2008, pp. 34, 35]. The distracted, tactile, habitual perception of the object that causes an artistic reaction (be it an object or an architecture) sacrifices its cultural character for that immediately manifest. A brief study present only in the first draft of the essay (before 1936) unequivocally clarifies this concept: "Whoever strives to understand a Romanesque cathedral must first have an idea of what happened to a man of the Romanesque period upon entering it. […] More or less the same as what happens to a man of our day when he enters into a garage" [Benjamin 2017, p. 151]. A different perceptual register is therefore proposed to contemporary man –to the masses, to put it in the words used by Benjamin– with respect to what happened in the past. Again different is what is offered thanks to the innovative tools of virtuality in which the technological exuberance –in some respects– can counteract the loss of the aura and rituality, although posing countless other problems for users.

Finally, we here point out an aspect that could be defined as evocative. In Section XI, entitled *The Painter and the Cameraman*, Benjamin proposes a comparison between the two dissimilar figures of the *pictor* and the cinematographic operator, that is, of those who work figuratively, with traditional means, and those who intervene with highly technological equipment: "How does the cameraman relate to the painter?" the critic asks, and he adds that to answer this he must take recourse to an analogy with a surgical operation. "The surgeon constitutes one pole of an arrangement in which the other is occupied by the magician. The stance of the magician healing an invalid by laying-on of hands differs from that of the surgeon performing an operation on that invalid. The magician maintains the natural distance between himself and the patient; to be precise he reduces it only slightly (by virtue of a laying-on hands) while increasing it (by virtue of his authority) hugely. The surgeon does the opposite: he reduces the distance to the patient a great deal (by actually going inside him) and increases it only a little (through the care with which his hand moves among the latter's organs). In short, unlike the magician (still a latent presence in the medical practitioner), the surgeon abstains at the crucial moment from facing his invalid person to person, invading him surgically instead" [Benjamin 2008, p. 25]. Therefore, "Magician and surgeon behave like painter and cameraman. […] The images they both come up with are enormously different. The painter's is an entity, the cameraman's chopped up into a large number of pieces, which find their way back together by following a new law" [Benjamin 2008, p. 25]. If we were to try to replace the two terms of the Benjaminian comparison, the figure of the traditional draftsman and that of the cameraman, with advanced modeling/visualization tools, the equivalence would probably remain unchanged. In particular, the images in "a large number of pieces" of which he speaks call to mind some procedures, well known to those who work with digital photogrammetry and image processing, such as modeling from photographic sampling and digital photomosaics.

A final note concerns the theme of magic, already mentioned by the author, which in the way it is presented, recalls the description proposed by Ernst Kris and Otto Kurz in a book published before the essay was written, entitled *Legend, mith and magic in the image of the artist*: a historical experiment [Kris, Kurz 1934]. The second chapter of this book, in fact, is entitled *The Artist as Magician* and describes the artistic ability of "copying" reality, from Zeuxis to Giotto, from Daedalus to Pygmalion. It is unclear whether this book was known to Benjamin: certainly some reflections seem profoundly anticipatory of ideas elaborated in *The Work of Art* by the German intellectual who, as was his habit, drew the most precious reflections from the 'depths' of the great thinkers of today as well as of the past. So much so that he can be considered an extraordinary "pearl diver" [Arendt 2004, p. 61] [18].

Notes

[1] For the title, the first Italian translation from German [Benjamin 1966] was used, confirmed in later editions. We mention the variation suggested recently by Salvatore Cariati, Vincenzo Cicero and Luciano Tripepi which replaces the term '*epoca*' with the term '*tempo*' as a translation of '*Zeitalter*' [Cariati, Cicero, Tripepi 2017, p. CXXVIII, No. 6]. All the citations from *The Work of Art* were taken from Benjamin 2008. The other ones are translations from Italian versions.

[2] The bibliography on Walter Benjamin is vast: for brevity we indicate the bibliography presented in the recent biography: Eiland, Jennings 2016. The bibliographic references are found on pp. 661-676.

[3] See Benjamin 2013; also see the recent Italian edition [Benjamin 2017] with bilingual text (German-Italian), which presents a rich documentary apparatus. In the latter, the list of the five versions is found on p. CXXII and the synopsis of their structure at pp. 206-207.

[4] The letters are those of February 27 and 29, and of March 14, 1936: cf. Benjamin 2017, pp. 326-337 and 342-345.

[5] The sentence is present in the letter of February 29: cf. Benjamin 2017, p. 333. Likewise, the author will also write in that of March 14: "Brill […] has erased entire passages behind my back": cf. Benjamin 2017, p. 343.

[6] See, for example, the letter from Horkheimer to Benjamin dated March 18, in Benjamin 2017, pp. 346-353.

[7] The quote is taken from Benjamin 2011, p. XLVII. Also see: Benjamin 2017, p. XXIV.

[8] The essay was published between September and October 1931 in the journal *Die Literarische Welt*, in issues 38 (18/9), 39 (25/9) and 40 (2/10): cf. Benjamin 1931 and the Italian translation in Benjamin 2012, pp. 225-244.

[9] Speech held at the Institute for the Study of Fascism in Paris on April 27, 1934. Italian translation in Benjamin 2012, pp. 147-162.

[10] Quoted by Benjamin himself: cf. Benjamin 2017, pp. 84-85, No. 20.

[11] Also mentioned by Benjamin: cf. Benjamin 2017, pp. 82-85, No. 20.

[12] We can summarize the events related to the publication and dissemination of Panofsky's essay: the first appearance is in the journal *Der Kreis* on the explicit request of the editorial board [Panofsky 1930]. The contribution was then completely forgotten until it was reprinted in *IDEA. Iahrbuch der Hamburger Kunsthalle* [Panofsky 1986] followed by a critical essay by Michael Diers on the topic of art and reproduction [Diers 1986]. Thanks to this rediscovery, the *Eidos* journal proposed an Italian translation of the text [Panofsky 1990] with a brief introductory note by Carlo Bertelli on page 4. In 1998 it was included in a collection of essays by the scholar [Panofsky 1998]. It was then republished, translated into English, in 2010 in the journal RES: *Anthropology and Aesthetics* [Panofsky 2010] with translation by Timothy Grundy.

[13] The titles of the Sections are only present in the second edition, dated October 1935, and reported in Benjamin 2017. Also see, in the latter, the index in the *Apparatus Maior* at pp. 171, 172.

[14] We omit the premise bearing a specific political connotation, which determined its exclusion from the first publication.

[15] Benjamin cites from the Section *La conquête de l'ubiquité* [Valéry 1934, p. 105]. See Benjamin 2017, pp. 12-15.

[16] See in particular the Section *M.* entitled precisely *Il flâneur* [Benjamin 2000, pp. 465-509].

[17] The text in the *Little History of Photography is*: "To pry an object from its shell, to destroy its aura, is the mark of a perception whose 'sense of the universal equality of things' has increased to such a degree that it extracts it even from a unique object by means of reproduction" [Benjamin 2012, p. 237].

[18] We borrow the definition of Benjamin given by Hannah Arendt, used to name a chapter of the biography written for him, also present in the text, which we quote in full: "Like a pearl diver who descends to the bottom of the sea, not to excavate the bottom and bring it to light but to pry loose the rich and the strange, the pearls and the coral in the depths, and to carry them to the surface" [Arendt 2004, p. 78].

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Events

Events

5° INTBAU International Annual Event

Giampiero Mele

Much of the existing cultural heritage, tangible and intangible, deserves to be known, preserved and valued at its best. Heritage is fundamental for the maintenance of diversity. Its importance is not in the cultural manifestation itself, but rather in the wealth of knowledge and skills that are transmitted from generation to generation.
In this regard, every year the INTBAU association [1] promotes an annual international event that is hosted in rotation by one of the nations represented in the association. In July 2017 the 5th INTBAU International Annual Event took place in Italy at the Department of Design of the Polytechnic of Milan.
It offered two initiatives: a conference and a study tour. The title of the meeting, *Putting Tradition into Practice: Heritage, Place, Design*, is founded on one of the current of the scientific research challenges, which aims to spawn new knowledge starting from the widespread cultural heritage in the territories and transmit it in the architects' work for the dissemination of good practices in the fields of survey, as well as of the drawing representation and urban regeneration. The Study Tour, entitled *The stones of Vicenza, the classical tradition in design and drawings*, offered to the participants the opportunity to acquire a deeper understanding of the classical tradition, taking the architecture and landscapes of Vicenza as study material.
The aim of the conference was to investigate the techniques of communication, representation and enhancement of cultural heritage and historical urban landscapes. It also endeavored a promotion of the *placemaking* and strategic design methodologies that support the traditions of the territories. This has been an important opportunity for discussion among scholars who deal with these issues [Amoruso 2018, p. XXXI].
Some events happened in the last years have struck the public opinion producing huge outcry: the destruction of the arch of triumph in the ancient city of Palmira (5 October 2015) and the catastrophic earthquake affecting numerous communities in Abruzzo, Lazio, Marche and Umbria (from August 2016 to January 2017) have caused enormous injuries to cultural heritage. Speaking about Italy, our Country is facing a major challenge and must not only respond to the housing needs but also rebuild a wounded community by creating architectural and urban solutions that confirm the principle of cultural continuity.
This is the most important program of reconstruction after the war which will focus on social and economic policies and on the application of new technologies, putting together a multi-disciplinary scientific research useful for the rebirth of the wounded communities now deprived of their places of aggregation and their identity.
If buildings and cities are a portrait of the human condition, it is up to scholars and citizens, with their skills and expectations, to invest resources so that heritage remains alive in the uses and forms of every life, in rituals and traditions.
International organizations, such as UNESCO, recall the community to protect all assets including those that who do not express themselves through artefacts and that are carried out in the gestures, in the sharing of images and in the social perception that dwells in the communities. Cultural heritage in general consists of products and processes of a culture that are preserved and passed down through generations. In this context, the INTBAU 2017 initiative is included. It has promoted the exchange and updating of research and best practices in the disciplines of cultural heritage and architecture, with the contribution of experts, universities, professionals and public institutions. For this reason, the initiative was sponsored by the

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Fig. 1. 5th INTBAU International Annual Event - Posters of the two events.

scientific society UID (Italian Union for Design) which actively contributed to the program. The Conference [2], was attended by 255 experts. 80 contributions were selected [3] and proposed to a wide range of national and international researchers and professionals to answer to some of the topical issues. The main topics discussed during the conference were:

- how global intelligence can support sustainable local development;
- a particular focus about the question of how to rebuild after a seismic event or a natural disaster;
- how to develop knowledge of cultural heritage and places and how the identity of the territories can be transformed into design guidelines to support the growth of local communities;
- how to build better houses, durable and safe and how to work together to find solutions to global challenges.

The 2017 edition of the annual event of INTBAU conference, since the launch of the international call for papers, obtained an extraordinary response witnessed by 200 contributions from 255 authors. The admitted contributions were 165 [4], from 64 universities from 20 countries and 5 different continents.

The members of the Italian Union for Design (UID) participated with specific contributions on the issues of drawing as a tool for generating knowledge, experimenting and integrating tools and methods of representation, from traditional analogical to innovative digital ones, also for the management of complex systems. The other partners, such as the Agenzia Italiana per la Cooperazione allo Sviluppo (Italian Development Cooperation Agency), the UNESCO National Commission, the ICOMOS Italy and some leading companies in the various sectors [5], contributed in their own way to the success of the event.

During the various and varied program of the conference [6], during the first day (5 July), institutional interventions were presented, such as those of Luisa Collina (Pro-Rector for External Relations of the Milan Polytechnic), Silvia Piardi (Director of the Design Department of the Milan Polytechnic), Antonella Ranaldi (Superintendent of Archeology, Fine Arts and Landscape for the metropolitan city of Milan) and Vito Cardone (President of the UID). The conference began with an opening message by prof. Giuseppe Amoruso and Robert Adam (President of INTBAU). For the occasion, the Prince of Wales sent to the participants of the conference an official message in which he recalled the commitment of the professions and research in ensuring a future of prosperity to the Italian territories affected by the earthquakes. The message also recalled the responsibility to ensure the right resilience in respect of the traditions that make these places characteristic and which must be maintained. It is an extraordinary witness of closeness to the communities affected by the earthquake so that they can be significantly involved in cultural issues that affect the reconstruction programs and the promotion of the sites in accordance with the identity of the people, to ensure

secure and resilient homes. Rossella Salerno (Polytechnic of Milan), Michael Mehaffy (KTH Royal Institute of Technology, Sweden), Gabriele Tagliaventi (University of Ferrara), Raffaella Bassi (Neri Foundation - Italian Museum of Cast Iron) participated among the numerous guests and experts. In this session examples of best practices for reconstruction and answers to frequently asked questions related to the regeneration and reconstruction of cultural heritage have been presented. During the second day (July 6th) issues concerning documentation and promotion of cultural, architectural and urban heritage were dealt with as well as related knowledge through drawing, the identity of places, design tools, the new urban agenda and international cooperation.
During the sessions, solutions for the reuse and conservation of the variety and diversity of assets were presented, as well as the material representation of regional cultures and traditions that have developed in relation to the geographical and climatic conditions of the territory and the availability of resources and local materials. In the final session, reflections on the renewal of the foundations of knowledge were shared and the final focus helped to indicate some lines of cultural policy lines for the implementation of the New Urban Agenda and for the construction of collaborative schemes to face global challenges.
After the conference, from July 7th to 9th, the *study tour* was held in Vicenza. It gave the opportunity to students, PhD students and teachers from different countries to deepen their knowledge in the field of the classical tradition. For this purpose, the architecture and landscapes of Vicenza were used as study material. The urban landscape of Vicenza and the surrounding countryside offered a unique sense of place through the local emergencies of the highly influential architectural heritage of the sixteenth-century villas of Palladio. Knowledge of classical works was deepened through the use of drawing as a learning tool.
Drawing experiences have been carried out in many of the places where Palladio's architecture stands. In particular, a systematic study of the Vicenza Olympic Theater was launched, carrying out a survey using the most advanced three-dimensional technologies. The model obtained allowed to study the geometric structure of the form inspired by the Vitruvian canons. The principles of the theater's perspective scenography have been analyzed.
It was also investigated the possibility of promoting knowledge through the creation of copies and tactile models to be used for educational purposes by means of virtual visits accessible through the web.
This important event – held between Milan and Vicenza – has encouraged interaction among different design cultures: it produced an interesting scientific discussion on the experience of established practices and innovative solutions for new challenges and has set up the international network of researchers, professionals, companies and institutions that consider important to spread the message that memory and cultural identity should be enriched and substantiated by means of scientific, professional, organic, conscious, economically articulated and respectful knowledge of architectural traditions and of the individuals who are part of it.

Fig. 2. 5th INTBAU International Annual Event – Proceeding of the conference presetantion.

Notes

[1] INTBAU (acronym of International Network for Traditional Building, Architecture & Urbanism) is a no-profit network founded and sponsored by the Prince of Wales, in charge of promoting the many traditions of the building and their practical applications to face the challenges for the protection and enhancement of built heritage.

[2] The scientific direction of the event was entrusted to prof. Giuseppe Amoruso, Milan Polytechnic, and Antonella Ranaldi, Superintendent of Archeology, Fine Arts and Landscape for the metropolitan city of Milan.

[3] The selection of contributions took place through the duble blind peer review process *double blind peer review*.

[4] Thirty-five contributions were sent by PhD *student*.

[5] Among the companies we mention Topcon (technologies for surveying, positioning and efficiency in the industrial and agricultural sectors), Neri (products for lighting and street furniture and which, through the Fondazione Neri, publishes the magazine Arredo & Città), Morseletto Laboratory (extraction and processing of stone materials), Nankai (paints and instruments for quality control of color reproduction), Hassel (Communication and social campaigns), Cam2 (services for surveying), Buonavita (products with zero kilometers).

[6] <http://www.intbauitalia.org/meeting2017> (accessed 2018, February 15).

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Events

Immagini? Transdisciplinarity of Drawing

Francesco Maggio

The discipline of Drawing has always dealt with innumerable questions concerning vast areas of knowledge; representation in its purely scientific aspects, the History of the discipline itself, the built or natural or prefigured environment and, more generally, Cultural Heritage, as well as the new and increasingly advanced digital technologies and, lastly, the aspects of visual culture. For some time, scholars in the field of Drawing have requested opinions, contributions, "points of view" from other scholars who, although they do not belong to the specific scientific area of Drawing, augment the knowledge on the themes and issues that Drawing poses.
An important attempt at multidisciplinary "openness," to be honest, had already taken place in the 1980s when Margherita De Simone inaugurated in Palermo the fortunate season of the *Spring Seminars* involving scholars of the caliber of Maurice Cerasi, Salvatore Mazzamuto, Tommaso Giura Longo, Vittorio Gregotti, Tomás Maldonado, Rosario Assunto, and, subsequently, in 2006, when a group of then-young teachers of the area of Drawing proposed the *Ideas for Representation* annual seminars intended to stimulate reflection on the role of representation in current times through interdisciplinary contributions, seen almost as a necessary step for discerning new horizons of research.
This "necessity" is "necessary," and the rhetorical figure is certainly helpful, especially when the disciplines of Drawing go beyond the boundaries of the Faculties of Architecture and Engineering to offer and exhibit their own contribution, and their own potentials, in educational structures in which the direct relationship with construction is absent; in places where the nature of Drawing is understood only in its purely pedagogical form.
The *Immagini?* Conference (fig. 1), well-organized in Bressanone at the Faculty of Education of the Libera Università di Bolzano by Alessandro Luigini, Demis Basso, Stefano Brusaporci, Enrico Cicalò, Massimiliano Lo Turco, Valeria Menchetelli, Matteo Moretti, Chiara Panciroli, Daniele Rossi, Maria Teresa Trisciuzzi and Daniele Villa, was a moment of confrontation on the broader theme of "Image/Imagination" intended by the organizing committee, as written in the flyer of the conference, almost as a pretext for triggering an interdisciplinary confrontation by «whoever is convinced that Knowledge is a heritage in progress, always open, which is built first of all by formulating questions for surpassing limits and borders. And the question which gave rise to the conference was rather simple: how do scholars working in different disciplinary fields investigate the relationship between image and imagination? Thus the scholars of representation, visual communication, education, psychology and many others were invited to discuss a common field of research, in which everyone moves in a different way.
It is precisely this "cohabitation" that makes the relationship between image and imagination a fully interdisciplinary, or rather, transdisciplinary field: the world of the image and the visual is a world in which all the disciplines listed above rightfully express their own theories and practices, also legitimized by the mutual recognition of all-too-occasional interactions».
Starting from this question, after the welcoming remarks, opening address and speeches by the keynote speakers, eighty-eight papers were presented in the four parallel sessions organized during the two very busy days. Paul Videsott, Dean of the Faculty of Education, and Vito Cardone, President of the UID, Unione Italiana per il Disegno, in presenting their greetings, highlighted the multidisciplinary nature of the Conference, hoping that this would not only give rise to new ideas for reflection,

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Fig. 1. Immagini? The poster of the Conference.

but also trigger collaborative research processes among teachers of different sectors, also in relation to the teaching of Drawing in the Schools of Education. To the non-neutral objectivity of the term "image," the organizing committee joined the much more subjective term "imagination," probably to also identify an evident term of interdisciplinary contact; for this reason, the interventions aroused multiple interests legitimizing the validity of the initiative. In fact, experiments concerning the impact and the construction/manipulation of images by children aged two to four, as presented by pedagogues and psychologists (Molina, Frezzotti, Cardellini), were joined by "stories and events of the imagination" regarding architecture (Palestini, Romor, M. Rossi, Massari, Pastore, Spallone), street art (Zerlenga), "pure visibility" (Sdegno), "art therapy" (Borgherini), scenography (Centineo), use of the media for knowing and understanding (Casale, Ippoliti), visual perception (Garofalo), semiotics of artifacts (Gay, Cazzaro), narration (Quici).

This important event organized in Bressanone stemmed from the conviction, as written by the organizing committee in the flyer, that «the image in the 21st century is digital, pervasive, rapid. It is an image filtered by mobile devices, both incoming and outgoing, which is produced, consumed instantly and delivered first to anyone (even those who we do not know, and perhaps would not want to know) and then to a stationary oblivion, relegated into a condition of unattainability (the temporal proximity relationship being broken) in which it is however impossible to completely erase its traces. The image in the 21st century is a space. It is a visual space, formed by known dimensions but whose depth is to be discovered, in which we act and build relationships through imagination. The image in the 21st century is immersive, in a constant balance between the three-dimensionality of fruition and the two-dimensionality of the projection.

The image in the 21st century is, even more than before, the preferential vehicle for the development of imagination and conception, for the typical conformation of figurative creativities (architecture, painting, comics, visual design, infographics, etc.). The image in the 21st century, today, is a visual experience that produces a gaze that leads to the imagination».

If this is true, it is possible to ask the question: does a non-immersive space, even non-digital, not of rapid use, which can instead be investigated calmly, still exist? A "slow" space that induces to reflections that have the time of their duration; a visual space that can show a search for meaning. Or is everything referred to rapid fruition?

At the end of the day, Oliviero Toscani, almost a guest star of the conference, somehow gave an answer to these questions. «Almost everything we know today, we know because we have seen images», said the Milanese photographer, «and these images do form our conscience, our judgment and our morals. History has existed from the time photographic images first existed, before that moment, there were 'deceptions,' drawings, paintings... If a camera had existed then, perhaps the Bible and the Gospels would never have been written» [1].

With his extensive portfolio, the photographer of Benetton, Chanel, Fiorucci and Vogue chose to completely disregard other forms of art, exalting the photograph as the only expressive form, not taking into account those "deceptions" of which he obviously lacked the tools for verifying their impact. Fortunately, photography as a tool for constructing images, imaginary and imagination was clearly delineated by Nicolò Degiorgis who, with slow rigor, presented his research on the "hidden" Islam and also the methodological construction of a photographic exhibition that, starting from the painting by Simon de Myle depicting Noah's Ark on Mount Ararat (fig. 2), which concerned current issues such as integration, the search for identity and the fragility of democracies, while suggesting to visitors a reinterpretation of the concepts of *Heimat* (homeland) and fatherland (fig. 3).

The work of this photographer from Bolzano showed that there are no fences or narcissisms and that photo-

graphy has a close relationship with the history of art, of which it is a part, and not a mere object of commodification. The multiplicity of the subjects dealt with during the conference does not allow a complete description of its structure and contents, but certainly leads to a consideration not only of a disciplinary nature but, above all, related to didactic aspects.
In his lecture, Vito Cardone pointed out how, twenty years ago, the teachers of Drawing also faced the challenge of teaching study courses in Education, often reaching very positive results.
That drawing has a pedagogical role is known to all and it is enough to say that it is an expressive modality; a language.
Franco Purini, in a 1983 paper, stated that the professor of Drawing is a «primary teacher: he introduces students to a discipline so complex as to be extraneous to most of them even after graduation, and he must abandon them as soon as they are able to produce only an uncertain babble. He is precluded from fully teaching grammar; he can scarcely hint at a syntactic 'step.' He is therefore a censored and halved elementary teacher who must not forget that in the etymology of the word *disegno* (drawing), *designare* (designate), that is, to choose after giving meaning to things, hides all that is important in the profession of architect» [Purini, 1992, p. 347].
To Alessandro Luigini, and to all the other members of the conference's organizing committee, we must give the credit of having emphasized that Drawing, once again, is instrumental, as Martin Heidegger defines the "thing" in *The Question Concerning Technology* [Heidegger 1976].

Fig. 2. Simon de Myle. Noah's Ark on Mount Ararat, 1570. Oil on canvas.

Fig. 3. Luca Turi. The Vlora alongside the quay in Bari, 1991.

Notes

[1] See <https://www.facebook.com/IMG2017/videos/1734634106557015/> (accessed 2018, February 17).

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Eventi

Ai Confini del Disegno: One-Day Seminar on the New Technologies for the Representation of Cultural Heritage

Fabrizio Gay

On January 10th, 2018, one-day seminar dedicated to the new technologies for representation, knowledge and enhancement of architectural and artistic heritage was held in Gorizia, Italy. The initiative was funded by the Intra-University PhD Program in Civil-Environmental Engineering and Architecture of the University of Trieste and the University of Udine and by the Fondazione Cassa di Risparmio di Gorizia, and organized –as vice-coordinator of the PhD program– by Alberto Sdegno, the well-known scholar of the history of architectural representation and lecturer active on the experimental fronts of drawing.

As it is known, the topic is that dealt with by several international conferences (now held at approximately ten-year intervals) on Digital Heritage and Built Heritage, in the fields of Digital Humanities or in those of Computer Graphics and Computer Vision. Compared to these vast international encounters on the most recent technological advances, the small meeting held in Gorizia asserted its own *rationale*, offering a point of view closer to the real sense of the applications and of ongoing research. It offered a precise "on-site" verification –in the midst of extant territorial realities– of the most widespread theories and techniques addressed to the topic. The one-day seminar was intended, first and foremost, as an occasion for bringing together ongoing research and territorial vocations, that is, as a meeting between different players of built and artistic heritage: practicing professionals –represented especially by the Chamber of Architects (in the person of Diego Kuzmin) and the Board of Graduate Surveyors (in the person of Luana Tunini)– local administrators and entrepreneurs of the area, with a selected group of experts in the field and with students from secondary schools, the university and the PhD program. The meeting, therefore, called for an adequate variety of communications, attained mainly by dividing the one-day seminar into two sections: a morning opening conference, held in the basilica hall of the former Archiepiscopal Seminary, now the Aula Magna of the seat of the single-cycle degree course in Architecture of the University of Trieste, and in an afternoon itinerary of guided tours: starting from the Advanced Modeling 3D Lab/Architecture laboratory (of the University Pole of Gorizia), then passing through several sites in Gorizia at which there are installed –or being implemented– advanced display systems for museum communication.

The tour started by testing the products of the Advanced Modeling 3D Lab/Architecture: especially some applications for the survey of three-dimensional elements and others for navigation in augmented and virtual reality conceived for the use of spaces which were reconstructed on the basis of perspective analysis of painted scenes –especially that of Veronese's *Feast in the House of Levi*– or no-longer-extant historical architectural works –such as the *Pavillion de l'Esprit Nouveau* in Paris– as well as several tactile maps created in the context of the *Gorizia conTatto* project, with a theme dedicated to the haptic enjoyment of works of art. The *Gorizia conTatto* project –coordinated by the local sections of Italia Nostra and the Unione Italiana Ciechi e Ipovedenti (Italian Union for the Blind and Visually Impaired)– also involves several institutions hosted in Gorizia which were also included in the visit. More precisely, at the Fondazione Palazzo Coronini Cronberg, curator Cristina Bragaglia presented the touchable reproduction of two mid-eighteenth century "character heads" by Franz Xaver Messerschmidt, alongside the original ones displayed in protected showcases. A similar work of haptic translation of visual figurative objects has been undertaken at the Church of St. Ignatius, visited with an introduction by Maddalena Malni Pascoletti (for Italia Nostra).

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Fig. 1. Poster of the event.

Here the tactile planimetric map of the building is only the first part of an investigation making use of the perspective reconstruction method –at the PhD school of Gorizia– of the magnificent quadratura of the fresco on the wall behind the high altar, a work by Christoph Tausch –student of Andrea Pozzo– dating from the first half of the 18th century. From this process –as Alberto Sdegno explained– a new and concrete joint *mise en scene* will be realized, both of the solid architecture of the church, as well as of its expansion depicted in the fresco.

In this kind of "translation," what is at stake is the enhancement of places and works of art; it is perhaps for this reason that the last stop on the tour of Gorizia was the Castle, the most important monument of this city crossed by the Isonzo River. Here the presentation by Diego Kuzmin provided a general outline of the urban history of this place, up to the controversies concerning the current layout of the castle, heavily "restored" in the 1930s.

In short: the one-day seminar in Gorizia highlighted the fact that the real issue at stake for what regards the subject in question is essentially a matter of "re-mediation," that is, of the translation of systems of values by means of different media: painting, sculpture, photography, cinema, museum exhibitions, videogames, etc. Being an essentially media-related issue –relating to multi- and trans-media– the most relevant aspect today is not only that of the technological innovation of IT devices –an aspect that is experiencing unprecedented developments– but, above all, that of the concrete sense of their material applications, in the places physically experienced by "re-mediation."

It is perhaps for this (media-related) reason that today, in terms of representation technologies, the (very inclusive) tradition of research represented by the UID (Italian Union for Drawing) scientific society (which for the last forty years has dealt with research and university teaching while attempting to embrace the whole spectrum of practices ranging from survey and representation of the built environment to communication), has a good advantage. The UID –officially represented by its president and vice-president– thus provided the one-day seminar with a disciplinary framework, through the morning opening conference entitled *At the borders of drawing: experiences of virtual models and immersive spaces*. The conference was introduced by the president of the UID (Vito Cardone) who stressed the relevance of the conference's disciplinary framework, which was then further specified in the following lecture by the vice-president, Mario Centofanti. He recalled the status of the performance formulations (scientific and practical) to which the representations of cultural heritage should abide, at least those that emerge from important political documents, that is, the 2003 UNESCO Charter on the Preservation of Digital Heritage, the 2009 London Charter for the Computer-Based Visualisation of Cultural Heritage, as well as the principles elaborated in the International Forum of Virtual Archeology held in Seville, Spain in 2011.

In this framework, the opening conference featured the very clear exposition of many invited papers presented by young professors from Italian and foreign universities who, introduced by Alberto Sdegno, described their own activities of research in the sector.

In his presentation, Sdegno highlighted the pervasiveness of the new technologies of representation which, in fact,

Fig. 2. Gorizia University Pole, view of the Lecture Hall of the where the conference was held.

Fig. 3. 3D helmet tested during the Virtual Reality session at the end of the conference.

are increasingly becoming part of our daily habits, from workplaces to museum spaces. Among the examples offered by Sdegno, there was a reference to the new communication devices – often endowed with 3D virtualization technologies– that allow us to quickly visualize a hypothetical furnishing plan proposed by means of online shopping interfaces, as well as the now common possibility of reproducing, with a perceptive flagrancy, a real environment through the use of environmental simulators and interactive games.
The conference sought to delineate a variegated panorama starting with the traditional tools of graphic representation and reaching the forms of spatial simulation proper to augmented and virtual reality, without neglecting that "mixed reality" –a successful mix of the other two– whose applications are destined to see flourishing developments in the coming years. In any case, in Gorizia, it was above all referential and historical-artistic realities to be dealt with. For example, Palladio's Olympic Theater which – analyzed and surveyed by Giuseppe Amoruso of the Politecnico di Milano through new 3D mapping technologies– revealed a morphology that is more easily comparable with the results of the Vitruvian tradition. Or the city of L'Aquila, with the restitution of its appearance prior to the earthquake through the INCIPIT project –related to the construction of information paths in augmented reality– presented by Stefano Brusaporci and Pamela Maiezza. Particularly precise with regard to the referential performance of the survey was the comparison presented by Domenico Visintini, of the University of Udine. On one case sample, Visintini presented the comparison of various aero-photogrammetric shooting technologies with drones used in ima-

ge-based stereometric surveys, as well as different techniques for processing the acquired data, verifying for each the specific degree of accuracy in the construction of the 3D digital model.
A section of the conference was dedicated to the restitution of works documented only by images and to the intermedial communication of large images. With his contribution, Leonardo Paris (of Sapienza University of Rome) demonstrated the remarkable possibilities for the use of panoramic (spherical) photographs –including images of public domain present in the network– for the restitution of 3D virtual models of the reconstruction even of buildings and monuments –even those no-longer-existing– with an acceptable accuracy in the extrapolation of analytical data. Then, Pedro-Manuel Cabezos Bernal, from the Universitat Politècnica de València, in presenting some applications of digital photomosaics related to significant pictorial works with architectural subjects, showed the possibilities for the acquisition and processing of extremely high-resolution gigapixel images, in order to make them suitable for use on the web, in real time.
On the fundamental theme of surveying techniques known as Structure from Motion –which create 3D mesh models starting from sets of photographs– the contribution of Andrea Fusiello, professor of computer science at the University of Udine, provided a useful comparison between the algorithms used by the most popular photomodeling softwares. A comparison from which Fusiello pointed out the characteristics of the Zephir software, developed by his research team, rich in innovative elements in respect to other, widespread systems in the sector, and usable even by inexperienced operators.
In the last of the academic lectures, Alessandra Meschini, Daniele Rossi, Ramona Feriozzi and Alessandro Olivieri, from the University of Camerino, presented their research in the field of mixed reality which, using augmented and virtual reality apps, includes even physical models and concrete, designated sites as a real interface. On this occasion, the Ascoli group showed a stereoscopic navigation system with the use of 3D viewers offering the conference's participants the possibility to use a helmet for the immersive exploration of an architectural environment. This was the opening of the final section of the conference, dedicated to the direct presentation of equipment for an extremely variegated audience, for which the SoluTOP company described a typical series of digital survey tools – from 3D laser scanners, to GPS poles, up to photogrammetric drones– which were then made available in the afternoon, as part of the visit to the University Laboratory. The one-day seminar was concluded with a wish for an increasingly direct and situated experience.

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Events

Military Landscapes. A Future for Military Heritage

Anna Marotta

From the earliest history of mankind, the defence of territories and settlements has always been one of the most widely felt and implemented needs.
Even today, the material and immaterial heritage that has come down to us over the ages is a complex and articulated result of theories, treatises, models and systems, themselves varied in time and space, often recognizable and thematically classifiable by means of chronologies and mappings.
Configured, therefore, as cultural heritage characterized by the theme of the defence of the territory, the conference held at La Maddalena in June 2017 was proposed as a critical and intelligent synthesis of the various aspects and the various features with which the related phenomena and processes have developed.
The subtitle of the *Military Landscapes* conference well illustrates the content of the initiative: *A future for military heritage, for an international overview event celebrating the 150th anniversary of the decommissioning of Italian fortresses*. Curated by Giovanna Damiani and Donatella Rita Fiorino.
The University of Cagliari (DICAAR) [1], the Polo Museale of Sardinia (MiBACT), the Istituto Italiano dei Castelli (Sardinia Section and National Research Council) and the University of Edinburgh (ESALA) have promoted an international meeting to share case studies, paths of research and institutional initiatives concerning the knowledge, protection and cultural enhancement of historical military landscapes. In consideration of this heritage, the conference was held in La Maddalena at the Naval Non-commissioned Officers' School. The island, due to its position in the Mediterranean and its historical defence identity, constitutes a particularly significant microcosm, a symbolic place for reflection on principles and guidelines for the protection of international military landscapes. The first objective of the organizers was to initiate an interdisciplinary and inter-institutional dialogue on the issues of protection, reuse and management of military assets, in light of the new scenarios of reconversion or dual military and civil use.
With differentiated but integrated approaches, the interaction between military activities and the territory was again proposed, in asking: how can we recognize, interpret and protect this often discomforting memory, that alternates recollections of war, usurpation and violence, with more reassuring messages of security, commemoration, peace and progress?
The prospect of a new wave of decommissioning brings the theme of the reconversion of particularly vulnerable architecture and territories to the forefront. For the future of this heritage, in-

Fig. 1. Logo of the event.

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terdisciplinary dialogue becomes essential, in order to share methodologies of analysis of the sites and their contexts, protocols of conservation, surveillance and maintenance, strategies for cultural, economic and social valorization, restoration and conversion projects for civil use (residential, social, cultural, productive, tourist) or military, in the logic of the general rethinking of policies concerning defence and the reduction of public spending.
The initiative had as its primary objective the scientific reflection addressing an architectural and landscape heritage of great importance, not only under the historical-testimonial profile, but also in relation to the important socio-anthropological implications that this heritage underlies.
The redevelopment and re-use of fortresses and military garrisons for the knowledge and enhancement of historical military landscapes were also the theme of the international exhibition (produced by the Polo Museale of Sardinia with the University of Cagliari) that collected the results, through the thematic illustration of the scientific research projects presented. The exhibition –from 21 June to 21 September 2017– was set up on the island of Caprera, inside Forte Arbuticci a complex built at the end of the nineteenth century now the Giuseppe Garibaldi Memorial National Museum.
The exposition of the scientific and multidisciplinary contributions produced has better and more thoroughly, and in a timely and articulated way, illustrated the theme of the Conference, of extreme relevance: that of abandoned military structures, for a new reconversion to military, civil, cultural and tourist use of an important and strategic part of our cultural heritage, in a dimension of great divulgation.
The organizers have also planned the publication of the proceedings, in a 400-page book published by the prestigious Skira publishing house.
In the program, the articulation of the parts and thematic sessions emphasized the complexity and the integration of the methodological approaches.
In the first session A. *History and identity. Knowledge, analysis and representation* and, particularly, in A1. *Military cartography*, contributions worthy of mention included: *The fortress of Gaeta. A military landscape in graphic representations* by M. Cigola and A. Gallozzi, and *Graphic tools for attack and defence. From terrestrial magnetism to the scientific study of surfaces* by L. Carlevaris. For the session A2. *History, documents, permanences*, see in A2.1. *Pre-19th century defence sites*, see: *Fortifications in the Alessandrino area: a European itinerary in 'time'* by A. Marotta. Another noteworthy contribution was Annalisa Dameri's *Maps for defence. Military engineers' drawings in European archives*.
The history of European cities is strongly conditioned by the construction (and, after centuries, by the demolition) of fortified works. The European military archive, as well as state and municipal archives, are the custodians of the many drawings that testify how cities have been shaped by the demands of war. An important archival heritage that must be known, disseminated and enhanced.
The drawings of military engineers, often secreted for years as a strategic material for national security, in the course of centuries, once the urgencies of war had ceased, have been dispersed in various archival repositories. The study of several cities in northern Italy presented the comparison between drawings preserved at ISCAG in Rome, in the state and municipal archives of Piedmont and Lombardy, at the National Library of Florence, at the Biblioteca Nacional de España in Madrid, at the Archivo General of Simancas, at the Bibliothéque Nationale de France in Paris, at the archives of the Service Historique de la Défense in Vincennes, at the Bayerische Staatsbibliotek in Munich, at the Krigsarkivet in Stockholm.
The following session A2.2. *Secularization of Church property and military reuse* and A2.3. *Disposals and Demolitions*, included the essay, *San Luca degli Eremitani di Sant'Agostino in Parma: from convent to military structure. Historical analysis and architectural survey for defining transformability* by C. Vernizzi and *The walls of old San Juan during the 19th century by M. Flores Roman*, together with the paper on the *Decline and revival of a military urban landscape: the fortifications of Castelnuovo in Naples between 19th-century decommissioning and contemporary enhancement* by A. Pane and D. Treccozzi.
For the session A2.4. *Forts and barracks in the 19th century* and A2.5. *Prisons*, V. Martines analyzed the *History of the Maddalena Navy Military Hospital*, while G.B. Cocco, M. Diaz and C. Giannattasio looked *Beyond the walls of detention. The historical prison system in Sardinia*.
Among the session A3. *War landscapes of the 20th century, in particular*, the session A3.1. *Pre-19th century defence sites" comprised De-signs in the landscape and traces in the memory. The modern wars sentries of the Mediterranean Sea: an interdisciplinary research between Spain and Sardinia* by A. Martínez Medina and A. Pirinu, while C. Palestini confronted *Representing the fortified landscape: graphic interpretations of the Fortress of Civitella del Tronto*. Also of interest, the paper by P.I. Schneider and C. Röhl, on *The ruin of the F1 missile factory building at Peenemünde and its archaeological intelligence. Methodology and methods*.
In A4. *Typologies and constructive techni-*

ques there was the interesting paper on the *Astura Tower and the defence of the territory: memories and present relevance of a historic landscape* by M. Docci and G. Teodori, in collaboration with the Territorial Technical Office for Land Armaments (UTTAT-Nettuno, Secretariat General of Defence / National Armaments Directorate).
Part B. *Military 'island' networks. Protocols for protection and reconversion policies,* and in particular session B.1. *Tools for Protection, Census and Catalogue* included a fascinating and international reflection on *Medieval fortified cultural landscapes of northwestern and central India* by J. Shikha and KN Prothi; while F. Novelli proposed an analysis, *From the 'Atlante Castellano d'Italia' to the fortified structures in Piedmont: conservation and new use and enhancement processes*.
Session B2. *Design and territory* featured an important work on the *Theory, methodology and feasibility study in the preservation of the Fort of Sant'Alessandro* by F. Bertè, followed by that of A. Rolando and P. Salvadeo, *From landscape 'museification' to 'revitalisation': research, thesis, projects of the Polytechnic of Milan*.

Part C. *Old and new functions. Plans and projects for renewed urban and territorial hubs*, in particular C.1. *Planning and urban design*, saw C. Van Emstede propose *Where preservation and urban planning meet: the reconversion of the shipyard Willemsoord Royal Netherlands Navy Shipyard*, while D. R. Fiorino dealt with *Defensive Stratigraphy. Studies for the preservation of Cagliari's military landscape*, similarly to R. Picone with the *Military Heritage at the San Vincenzo Pier in Naples. From a limit to an opportunity for the contemporary city*. G. Canella, C. Coscia and P. Mellano analyzed *The De Sonnaz Barracks in Turin: from military district to a justice hub for the design of a new urban landscape*. The latter essay established –among other things– the delicate relationship, often to be recognized and resolved, between large and complex abandoned settlements and the landscape and structure of the city.
In session C2. *Social landscapes*, it is important to mention the paper by G. Angelone, K. Russo and G. Krauss, *The protection of Terra di Lavoro's military landscape: the example of San Pietro Infine's park of Historical memory*, while for session C3. *Experimental design*, the essay by R. Mancini, *Rome seen from its city walls*, was outstanding.
Again in this session, of particular interest –also for the size of the complex concerned– the contribution of M.P. Gatti and G. Russo, of the Department of Civil, Environmental and Mechanical Engineering (DICAM) of the University of Trento. The subject was that of abandoned military structures, particularly Palmanova, with the problems of the physical and economic regeneration of quarters: a theme that was presented with particular criticality for different situations in Italy and in Europe. The typological aspects obviously cannot be separated from the structural and technological aspects, both on the level of knowledge and preliminary investigations, as well as on the level of concrete and operational solutions. If this is an approach valid for any intervention on existing structures, it seems particularly delicate in the case of historic artifacts, especially of considerable size, such as Palmanova. Consistently, one of the questions that this paper posed on a general level was the recognizability of historical-documentary values, of which the extant structure is the bearer, that must be safeguarded, albeit in connection with the strategies of reintegration into a circuit of new economic fruition, also effective on a functional level.
Together with some particularly interesting and positive aspects rediscovered and included in the new unitary territorial development program (in collaboration with the State Property Office), the paper did not neglect critical aspects, such as excessive bureaucratization, which has in fact blocked any specific proposal or initiative. As the article concluded, new regeneration strategies are needed to avoid damaging the abandoned military sites even further. Strategies based on

Fig. 2. Arbuticci Fort, Caprera, La Maddalena (Sassari).

the knowledge of their architectural and technological characteristics, and on the knowledge of local policies; but what is needed, above all, are real, contextualized, economically sustainable projects.
For what regards the special session S1. *Redevelopment, functional adaptation and management methodologies for civil and military dual use*, of particular interest were the paper by TK Kirova, *Good practices and models of intervention and management of military assets in use* and *HBIM for the conservation, reuse and management of military heritage. The case study of the Cascino Barracks in Cagliari* by D.R. Fiorino, S.M. Grillo, E. Pilia and E. Quaquero.
Session S2. *Military heritage for the arts and museums* treated *Fenestrelle: a fortress in Piedmont and its second life* by L. Accurti (MIBACT, Superintendence of Archaeology, Fine Arts and Landscape for the City of Turin, Italy). Also known as the "Great Wall of Piedmont," the fortified complex of Fenestrelle is a symbol of the province of Turin. The author traced the process of restoration and refunctionalization of part of the buildings of Fort San Carlo (that is, the lower part) including the visitor paths through the entire complex that has been returned to use and visitation with the educational and cultural function of a museum. In this project, particular importance was given to the restoration of the Royal Gateway, which made it possible to recover and enhance the main entrance to the Fort for conferences. Consistent with the vision of more contemporary conservation, a fundamental part was reserved to the phase of analysis and critical knowledge, while it was considered important to correlate the material interventions with those of a dynamic nature in the physical experience of the places. This interactivity was also interpreted in a virtual and digital sense. Finally, the notable dimension that was illustrated regarding the minimalist level of the interventions, implemented both in terms of non-invasiveness (in all senses) and in economic terms.
At the end of this brief excursus, intended as a concise summary of a broad, complete and irreproachable scientific initiative, we would like to mention what Sergio Polano wrote in his initial *lectio*, *Dazzle Painting*: «the first great futurist exhibition! The art of visual confusion in maritime military landscapes.» If Thomas Alva Edison had failed with his solutions for *camouflage* involving a large use of tarpaulins, the new technique (already adopted during the First World War) based on dyes and paints directly applied to the ship hulls enjoyed great success in Europe and beyond. The first campaign of unlimited submarine warfare was begun in February 1915 by the German *U-boot*, in open violation of the international conventions of the Laws of Warfare. The visual masking project was programmatically based on a precise application of *Gestalt* concepts and rules, with close connections with Vorticist movements. The critical selection of colors and their evaluation parameters was fundamental, first of all the tones and the *nuance*s, managed and applied (for example in England) by 11 volunteer assistants trained in various art schools for painting with *gouache*, according to typologies and with colors numerically coded according to a standard color chart. «Those who were not fortunate enough to see the docks at one of our great ports during the war –wrote Hugh Hurst, in 1919 in *Dazzle Painting in War-Time*– may imagine the arrival of a convoy […] of these painted ships, and the many miles of docks crowded with vessels of all sorts. […] Each resplendent in a variety of bright-hued patterns, up-to-date designs of stripes in black and white or pale blue and deep ultramarine, and earlier designs of curves, patches, and semicircles. Take all these, huddle them together in what appears to be hopeless confusion, but which in reality is perfect order, bow and stern pointing in all directions, mix a little sunshine, add the varied and sparkling reflections, stir the hotchpotch up with smoke, life, and incessant movement, and it can safely be said that the word 'dazzle' is not far from the mark.» This methodological approach, therefore, can also be considered among the "forms of defence." The interesting and fascinating graphic and photographic documents accompanying the essay confirmed the valid, relevant and effective role of Visual Culture in the art of war, in the military theater.

Notes

[1] The persons involved and their roles are as follows: Scientific Direction: Donatella Rita Fiorino, University of Cagliari – DICAAR; Institutional Reference: Polo Museale of Sardinia: Giovanna Damiani, Director; University of Cagliari: Donatella Rita Fiorino; University of Edinburgh: Miles Glendinning, Director of the Scottish Centre for Conservation Studies; Istituto Italiano dei Castelli: Michele Pintus, National vice-president

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