Handbook of Research on Visual Computing and Emerging Geometrical Design Tools

Giuseppe Amoruso
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A volume in the Advances in Media, Entertainment, and the Arts (AMEA) Book Series

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Foreword

The book presented by Professor Giuseppe Amoruso offers a whole overview of modern drawing tools used on graphic research.

Both digital processes applied to representation as those applied to geometric issues, included in the first volume and their specific design tools presented in the second volume show us an international overview that reflects the achievements of modern technologies applied to graphic representation.

The contributions from Italy, Cyprus, Spain, Brazil, United Kingdom, United States, Portugal, Argentina, Switzerland and Turkey, collect top quality researches on the field of drawing. This includes both chapters on documentation on Architectural heritage and chapters on form and geometry of buildings and historical monuments.

This international nature allows checking the diffusion of the latest computing progresses followed simultaneously all over the world. Not only 3D scanning techniques using sophisticated and expensive equipment, but also digital processing of surveys using low-cost instruments, allow levels of accuracy and amount of information which was unthinkable just few years ago.

Equally, modeling processes from random digital images without the need of a previous orientation, have opened a field of research that allows virtual reconstructions for 3D environments as well as deep researches on geometry, construction processes, textures, etc.

Traditional photogrammetry has also evolved dramatically during the last decade. Processing digital images allows a much more intense use of the frames: rectification of images, generation of photo mosaics, ortho photo maps, spherical panoramas, and many other applications have converted the traditional documentary photography in an tool of recording and collections of metrical data.

As often commented by Professor Mario Docci, “the deep knowledge of a work of architecture is only achieved after an accurate survey of the building is done...”, and when the written documentation and the traces that history and time have left on the monument are verified.

Nowadays, apart from the humble sheet of paper and the humble pencil, there is an arsenal of tools and graphic procedures available. This allows more comprenhensive and accurate survey than those done years ago, but it is has also to be kept in mind that the abuse of these instruments can lead to spectacular results at first glance but lacking a level of accuracy and definition which might allow us to achieve that “deep knowledge” which we quoted before.

The papers along these two volumes are exemplary in this sense. The first volume includes an overview on the use of leading computing procedures such as visualization, automatization, fractal geometry, Building Information Modeling, geometry, CAD, 3D modeling, etc. These are the emerging tools dedicated to drawing and to understanding of architectural spaces.

Geometry is a constant subject in this volume, either in purely theoretical articles or case studies of several historic monuments and buildings. This section includes examples of western architecture and also samples of other non western traditions, such as the underlying geometry in Islamic Architecture or some researches on stereotomy patterns in historic buildings in Cairo.

Chapters included in the second volume are oriented to the specific tools for the generation and composition of complex shapes, which are known as digital modeling. Reinterpreting the conventional architectural design workflow using these new tools allows the exploration of their spatial and formal characteristics. This last section also includes papers on emerging and modern computational techniques, such as the generation of complex geometries, parametric design, algorithms for surface generation or sustainable urban design, etc.

In summary, a wonderful book on the latest advances on emerging digital tools which allows an accurate and correct approach to the geometric and spatial analysis of architecture.

Pablo Navarro Esteve
Escuela Técnica Superior de Valencia, Spain
5 November 2015

Preface

This book is the result of a scientific challenge, the creation of a wide international network of experts with different background and expertise, from academic institutions and from the world of practice, that are pursuing the innovation in the fields of visual computing, descriptive geometry and digital design media.

The books collects peer-reviewed chapters dedicated to the emerging design tools and their new frontiers of knowledge where geometry is the starting point of generative design processes and a keyword for the understanding of our World heritage.

Riccardo Migliari in 2005 wrote a paper entitled *Has Perspective a future? (Has Man a future?)* addressing the "analogies between questions on the future of Man in the face of the disasters of the indiscriminate use of science and technology (during the era of the Cold War, but still of interest today) and some considerations on the future of the perspective (and the descriptive geometry) in the automatons era". With the outstanding contribute of Migliari, disciplines related to descriptive geometry are living a great revival thanks to new horizons opened by digital media and visual computing potential. These studies support the architectural and industrial design practice bridging the conceptual development through Cad tools with the final fabrication needs, allowing the visualization, the construction and the invention of complex forms (Migliari, 2009).

Visual computing is a multidisciplinary environment for scholars, practitioners, makers and users engaging the traditional challenges of design. Its broad field of influence makes studies about the subject attracting and continuously related to the evolution of workflows. For this reason the book includes chapters that cover several topics like geometry, descriptive geometry, digital design media, digital heritage, perspective-based design tools, generative tools, stereotomic design, technology and digital fabrication.

THE CHALLENGES

This volume, according to the several applications of descriptive geometry, addresses the paradigmatic formula geometry-visualization-construction-generation including the representation processes to visualize geometric design into the 3d environment, techniques of analysis, 3D data acquisition and prototyping.

The scientific challenge is to introduce the diverse emerging tools for the visualization of objects and shapes in the three-dimensional space creating the right framework to develop and build such complex shapes; a further challenge is to explore in depth the geometric environment with its relations, qualities, envisioning new expressions and new issues. This subject area is improving its impact into daily life and practice of designers since the introductions of several 3d printing technologies and low cost

applications; so the book make possible the encounter of people that are using high-level processes for generation of 3d shapes, visualization of complex geometries and prototyping of surfaces and solids for building and product manufacturing.

The book is designed as a reference source for Visual Computing because design and industrial design applications need to be fostered by interdisciplinary researches and best practices about the emerging methodologies and tools. Technologies and tools are investigated in their specific fields of applications and represent a high growth industry that involves a variety of users in the contemporary society, including media and design, industry of building, industrial design and manufacturing, heritage valorization, data visualization, independent designers and community of makers. With such a diverse body of applications, the research in visual computing for design and cultural heritage is always evolving and new theories, methodologies, tools, and applications are being presented in the book.

The book is conceived as support to design practice in the field of industrial design, architecture, and heritage documentation and fruition. As Marco Gaiani wrote we are living a new age in the field of data computing because today "the development of digital technologies as the real-time rendering (RTR) of 3D models and the Web 3.0 (i.e. semantic web, geospatial web, web 3D) opened new scenarios of reading and interpretation of historic architecture, introducing new methodologies of dissemination and information not merely related to textual searches but based on the geo-spatial & space-temporal navigation methodologies (Gaiani, 2015).

This research and editorial project challenges the issues of innovation and assesses the impact of digital tools according to traditional techniques of design and building. By exploiting the geometrical properties of forms, designers developed templates and construction methods that transform shapes in artefacts through empirical methods or sophisticated generative processes. Architecture, for example, must make an extraordinary contribution to the science of stereotomy that is living a progressive renewal thanks to studies of ancient sources and use of digital tools for parametric design and stone cutting (Fallacara, 2013). Crucial also is the role of descriptive geometry in designing and building the architectural space; for example techniques of perspective, distancing itself from the mathematical issues, become a projective tool to achieve painted or plastic illusory spaces that remind us that designing methods aim to add dimensions to the human sphere, creating new dynamism, not only in the physical one but also in the creation of material images and allegories. Descriptive geometry and disciplines of representation provide, in the many phases of project and according to several methodologies, the scientific and artistic tools for practical resolutions of geometric and constructive problems. Industrial design, interior design and building industries are really sensitive to the development of tools and processes that encounter the market need of low-cost and fast-track conceptual/fabrication tools.

The possession of a design tool, carefully selected to provide a balanced system to be able to operate in continuity in the various phases and appropriate to the goals to be achieved has always been a fundamental step in order to carry out projects and describe existing architectures quickly and accurately, and this for reasons intrinsic to the representative process (Gaiani, 2006). According to this concept, the book reviews emerging tools and processes that are changing the understanding of architectural heritage as well documented in the *Handbook of Research on Emerging Digital Tools for Architectural Surveying, Modeling, and Representation* by Stefano Brusaporci (Brusaporci, 2015). Digital tools are opening broad scenarios for new investigations as disseminated during the last international meetings of the U.I.D.-Unione Italiana per il Disegno in Rome, Matera, Parma and Turin.

The book is also dedicated to universal challenges as designing efficient forms in terms of static and aesthetic performance, building according to geometry, generating harmonious construction process, and understanding cultural heritage. This multidisciplinary approach presents selected researches and projects that are related to science and art of representation and visual arts, following the universal truth that the world is enriched through distinct cultures and traditions. Progressive researches are generating new branches of consolidated fields of studies like visual computing, cultural heritage and digital documentation, generative design and manufacturing.

ORGANIZATION OF THE BOOK

The book is organized into two sections and thirty-six chapters. Section 1 (chapters 1-18) describes the geometric, visual and projective tools for design and assessment of space including disciplines like descriptive geometry, computer vision, perspective tools for design, architectural perspective, anamorphosis, oblique projection, parametric design, BIM, digital heritage. Section 2 (chapter 19-36) reviews the geometric tools for building, construction process and generation of shape including disciplines like pattern based design, geometry based ornament, geometry of composition, geometric construction, shape grammar, pattern language, folding-unfolding, generation of complex shapes, 3D modelling.

A brief description of each of the chapters follows:

Chapter 1 identifies the existing challenges in the computer based visualization of the architectural heritage and investigate on its relationship with other disciplines. Digital tools are used indifferently and simultaneously in dissimilar research fields, and a clear definition of the ontologies, principles and procedures for advanced surveying, modeling, and visualization could allow the interdisciplinary collaboration.

Chapter 2 depicts the increasing emergence of digital practice in architecture. It is an essay that delves deeper into computational research in relation to several pivotal design experiences. After decades of improvements, computational thinking has led the design process to the post-parametric material instance: digital simulations and virtual optimization need to be translated into physical object hood.

Chapter 3 sets the framework on mathematical algorithm and nonlinear theories used in order to study the establishment and development of traditional settlements. The study investigates the fractal pattern of housing in Masouleh village, Iran. By referring to the fractal dimension calculated with box counting method, different type of information are collected and this attempt is helping decision makers, planners, architects and designers, especially in new housing developments.

Chapter 4 points out about the recent advances in acquisition technologies such as LiDAR, range cameras and photogrammetry that put point clouds in the forefront of several fields with applications in Computer Graphics, Vision and Machine Learning. The chapter focuses on how these fields can be combined in new and innovative ways, so that professionals can optimally exploit the advantages that these improved technologies can offer.

Chapter 5 presents survey methodologies based on spherical panoramas produced by image stitching techniques. It is an interactive survey system to generating 3D models of architectural structures and urban scenes. Photogrammetric fundamentals are applied using two different approaches to obtain the 3D model: by using texture-mapping techniques in the way of creating the virtual models; and by using parametric visual programming process.

Chapter 6 rewards with a valuable insight the more intimate aspects of the geometric reason for the Imperial Roman architecture and its ornamental patterns. It establishes the need for modern tools of understanding and the most progressive historic researches are offering extraordinary graphic suggestions for why elemental geometry was used in and how its meaning may be interpreted.

Chapter 7 illustrates the use of BIM tools for the reconstruction of lost nineteenth-century architectural heritage. Thanks to the properties of BIM to enter information related to each element constituting a building, every part of the model will be accompanied by information on the degree of reliability and references adopted for its creation. In this way, each family of elements could more easily and knowingly be reused for other similar projects.

Chapter 8 analyses the elements of architectural heritage in the Maestrazgo de Montesa, a Spanish region in the north western part of the province of Castellón. The methodology used three main sources of information: historical documentation, manual data collection and 3D scanner and photogrammetry. Starting from the data processing, it is possible to share such architectural knowledge with visual impairments people through tactile models.

Chapter 9 reviews the advantage of digital surveying to investigate the complexity of religious Baroque buildings while studying the church of Santa Maria dell'Odigitria in Acireale (Sicily). The three-dimensional space of a computer instead becomes the core of the unveiling process, the place where the scholar has the opportunity to interact, to question on the geometric and spatial qualities of the object.

Chapter 10 describes the use of the synthetic method through digital generative algorithms in the study of geometry. In particular, the paper describes the construction of a ruled surface given three skew lines in the mathematical representation method. Constructing algorithms for generating and controlling the geometric shape allows having a greater control on both the final form and on the generative process of form itself.

Chapter 11 presents digital representation technologies that can enhance the didactic activities in architectural training. A positive trajectory which includes the use of virtual reality, augmented reality and parametric modelling, as well as freehand drawing and the production of physical models both by automating the unfolding process and by digital fabrication processes of 3D printing and laser cutting.

Chapter 12 is talking about design visualization that seems to be matter of the contemporary era while talking about projection mostly pushes our feelings back to the past, despite even advanced digital visualizations are projection-based, or better, they are projective visualizations. These projective visualizations are not only mere supports to show design results but, mainly, they are irreplaceable thinking-and-operational tools for design development. Given their semantic wideness, these visualizations work as customized tools in the various branches of design.

Chapter 13 focuses on solving the problem to obtain oblique perspectives (or axonometric views) from a three-dimensional model, because it's a common lack in most CAD programs, since they only can produce orthogonal projections and linear perspectives from the model. This inconvenient drives to the fact that employment of this type of representations has been drastically reduced despite their importance in the design representation.

Chapter 14 introduces readers to the investigation of a controversial treatise entitled *Architectura Civil Recta y Obliqua* written, in the late XVII century, by Juan Caramuel de Lobkowitz; it is often mentioned by historians in relation with the debate around the Bernini's Vatican colonnade project in Rome. The book has been subject of a renewed interest in the recent past and, in the chapter, a systematic study that efficiently reviews the treatise is presented.

Chapter 15 presents the case of the *biais passé*, which was both a clear illustration of a special warped ruled surface but also an example of how constructors dealt with the problem of building a skew arch, solving structural and practical stone cutting demands. The representation of the *biais passé* in Théodore Olivier's model achieved a perfect correspondence to its *épure* according to Monge's Descriptive Geometry.

Chapter 16, dealing with illusion and reality, through the application of perspective-based design tools, describes the most important anamorphical representation in Italy and the architectural space that is hosting this masterpiece: the anamorphosis, a distorted projection and perspective painted by the French scholar Jean-François Nicéron at the Trinità de Monti in Rome.

Chapter 17 focuses on the architectural perspective knows as Quadratura: an illusory architecture is painted and the perspective projection creates the illusion of spatial depth on a flat or curved surface. This study developed an accurate survey and a digital 3D-reconstruction of the Palazzo Vizzani perspective, painted in Bologna by Antonio Galli Bibiena, through the graphic description of its projective system.

Chapter 18 concluding the Section 1, highlights the principles of projective-geometric design of illusory spaces illustrating the methodologies for the relief-perspective architectures which featured the architectural spaces during the sixteenth and the seventeenth century. The chapter analyses the relief-perspectives of Borromini and Bitonti and their partnership in the design of the perspectival tabernacle in Bologna and of the perspectival gallery for the Spada palace in Rome.

Chapter 19 opens the Section 2, and questions whether creativity is only applicable to the formal attributes of the repetitive pattern in parametric design; and also aims to examine how parametric design can undertake a repetitive pattern to simultaneously achieve remarkable creativity in its formal and perceptual issues. The chapter proposes an approach that enable designers to visualize the interaction between the organizational qualities and the perceptual ones of the composition.

Chapter 20 analyzes how a set of basic volumetric transformations can generate complex spatial outcomes. Using platonic solids as base volumes, different ideas are explored, applying generalized extrusions, mesh schemes of subdivision and multiplication of the object's faces, and a set of tools to create high-genus meshes. The goal of this process is to create a set of illustrated steps to activate architectural inquiry and to generate innovative design solutions.

Chapter 21 documents all initiatives taken in order to determine the geometric ratio in Islamic architecture passing over the exotic aura and looking for a formula able to explain how spatial, ornamental and constructive compositions remained constant along time. Emilio Camps Cazorla was one of the first Spanish theorists in searching that geometrical ratio which he called "Caliphal module" and that the study reviews through a series of graphical analysis.

Chapter 22 describes the Islamic Stereotomy in Cairo and the extraordinary Cairene domes. The art of stonecutting requires geometric knowledge which, although it starts with the professional practice at the workshop associated to the job, reaches extraordinary complexity and abstraction levels. In Islam, the passion for geometry finds in the masonry art a field where it can be developed without limits through the geometric tools of descriptive geometry.

Chapter 23 describes the geometry and the construction of vaulted and decorative systems called 'muqarnas', one of the most typical elements of Islamic architecture. This way of 'vaulting spaces', with a system of regular staircase-elements that break down the surface covering it with simple geometrical figures, derives from different generative geometries, and from building techniques and used materials. Drawing is the unique media to describe their remarkable complexity.

Chapter 24 reintroduces Stereotomy within the field of "research by design": the discipline, in fact, can be used as a means of re-composition of the design, project and execution phases. Particular attention is given to the prototyping workflow according also to historic treatises: seven stone prototypes, developed during recent years as a result of the attempt to combine multiple instances into a synthetic architectural object, are presented.

Chapter 25 makes new contributions to Borromini work and formulate new hypotheses regarding his construction practice in the building of the Dome of San Carlino alle Quattro Fontane in Rome. The comparison of the geometric construction of survey data and the design data develops the understanding of the original design idea, highlighting not only the designer's *modus progettandi*, but also matches, modifications or changes that featured the constructive challenge.

Chapter 26 proposes mathematical models of the vault of Borromini's San Carlino alle Quattro Fontane based on parametric curves and surfaces, including the shape of the vault and rules for its tessellation with crosses and octagonal coffers. Several models were tested measuring their distance from the 3D point cloud that was surveyed. The data analysis validates the hypothesis of construction procedures by checking symmetries of coffers shape, scale and position.

Chapter 27 starts from some considerations on the inter-scalar figurative relations which bind all the parts and details, within a work of architecture. The research investigated the portals by Francesco Borromini and the door cornices at Palazzo Falconieri in Rome. The comparison between the original drawings and the construction of the portal of the Orazio Falconieri apartment gave remarkable insights about Borromini mindful design and the built solutions.

Chapter 28 contains a geometric analysis of the architectural work of Rafael Moneo, winner of the Pritzker Architecture Prize in 1996. The result of the investigation is that the geometric component underlying his works has its roots in Platonic thought and that for Moneo, architectural ideas have an ontological nature, transcending the imperfection inherent in nature and approaching the perfection of Platonic order.

Chapter 29 reviews the teaching results from over ten workshops, with 'Unfolding and Folding' methodologies, developed in Chile, Argentina and Brazil to build up design projects that allow the spatial and material properties of architectural folded compositions to be investigated. The chapter proposes that design tools be updated through Parametric Design (2D generative patterns), 3D origami software and Digital Fabrication machines (CNC and Cutting Laser).

Chapter 30 investigates the connections between Visual Computing, which is oriented towards the representation of complex surfaces, and Geometrical Design Tools, which source from the movement created through dance, itself understood to be the art and technique of composing forms in space. In this area, a driving role has been taken by the Synthetic Method that analyzes surfaces as "geometric places", collective points in space that share the same properties.

Chapter 31 introduces a methodology for free form architecture engineering starting from a physical model of an arbitrary shape to a construction-aware detailed project. Free form architecture involves many problems of a geometric, structural and construction nature. The development of powerful tools such as parametric and algorithmic design software is allowing great freedom for shape design and remarkable control in managing large amounts of data.

Chapter 32 offers some insights on the incredible design opportunities offered by new computational instruments, as well as highlighting circumstances in which the act of 'modeling' takes over the 'design.' Parametric modeling allows to understand geometry and manipulate shapes in dynamic, articulated and yet intuitive ways.

Chapter 33 explains the use of geometrical algorithms to fix computing problems during the creative process when designing a product, resolving the continuous comparison between the digital and the real models. The need to compare the two models is due to the designer's need to construct full-scale prototypes.

Chapter 34 points out the parametric morphogenesis into architectural design, meant as the process of form creation, of the Gherkin skyscraper in London by Norman Foster. The geometric study addresses its shape characterization as the result of a synergy between environmental, structural and functional issues.

Chapter 35 presents a research on algorithmic approaches to formulate effective strategies for sustainable urban projects, guided by Transit Oriented Development (TOD) principles. TOD is an urban development model that considers geometric principles and measurable parameters for designing sustainable cities. The chapter focuses on the use of computational tools to provide quick and dynamic assessment while planning and discussing interventions in urban areas.

Chapter 36 concludes the Section 2 and the book, presenting the principles for the architectural modelling of an olive to estimate morphology and radiation relationship. The research integrates the study of trees with the science of representation, in order to investigate the relationship between morphology and light interception in a tree, starting from the case study of an olive, modeled without using any automation in survey.

This book is part of a wide project to create a base of knowledge and a repository for researches and applications related to the Second Industrial Revolution introduced by digital design media; as in the words of William J. Mitchell and Malcolm McCullough, a designer's view point is taken throughout: devices and techniques are introduced as a means of pursuing serious design intentions rather than as illustrations of the principles of computer science and technology (Mitchell & McCullough, 1995). The aim to combine knowledge about geometry, representation and descriptive geometry with emerging tools for cad, generation and visualization of shapes and spaces and new technologies applications is giving the opportunity to develop also a source about digital heritage and its multidisciplinary fields of applications. The book addresses a multidisciplinary target and research challenges, as requested from market and industrial/institutional bodies, encompassing the specialist audience, academics and scholars, and the end-users, students, practitioners and company employees. The effort is to encounter the strong interest about publications that starting from the solid roots of fundamentals and demonstrate how emerging processes and digital tools are innovating the fields of design and educational practices.

Concluding this preface it's important to acknowledge the 60 scholars from 31 Universities and 10 different countries which generously joined the research project and also created a solid framework of people who wish to innovate the applications of descriptive geometry and visual computing encouraging young people to get advantage from this knowledge. They shared their Art where art is a concept related to skills and ability coming from study and practice; a smart attitude, known since Greek philosophy as *Tekhné,* that can be developed through research and study.

Visual computing and geometric tools for design are arts embodying a wide knowledge coming from mathematics, optics, perspective, technology, computer graphics and other sciences that let the artist to be not only a talented artisan but also a *literatus*, a *polymathes* and *polytechnes* (Clair, 2015). Analyzing the practical thinking of visionary men like Antoni Gaudi it is possible to develop new disciplinary references for descriptive geometry whereas, in the laboratory of Gaudi, as well as in the contemporary designer studio, the ability to draw in space enables to use drawing as the descriptive geometry technique to bring together expertise and fabrication issues (Amoruso, 2013).

A practical philosophy, as the heretical Reason professed by Leonardo da Vinci, that after the intuition of knowledge takes action into the know-how practice. And, if for Leonardo each cognitive process starts with a feeling, whereas ‘’love wins everything”, then the need to use geometry and its analytical tools to understand the human universe is born from the irresistible charm and beauty of his inventions, of art and science.

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Ozgur Dincyurek was born in Famagusta on 1974. He is currently a Full Professor of Architecture at Eastern Mediterranean University and Chair of the Department of Architecture. He has a MS in Architecture Program and Ph.D. in Architectural Design History and Theory. His specific areas of expertise are architectural design, environmental design, sustainability, and vernacular architecture studies. He has given lectures related to the interplay between human beings and environment for more than 15 years. He has publications in vernacular architecture and sustainability studies at both national and international levels. Besides his academic works, he has been awarded by Fulbright Short term Training Scholarship (1999), Fulbright Visiting Scholarship (2008) and European Commission Scholarship for the Turkish Cypriot Programme (2009). He is the founding chair of the International Network for Traditional Building, Architecture and Urbanism, INTBAU Cyprus Chapter. He is also a voting member of INTBAU College of Chapters.

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Giuseppe Fallacara is an architect and researcher at the Department of Civil Engineering and Architecture at the Polytechnic of Bari. In the same faculty teaches Architectural Design and History of Stereotomy and follows numerous dissertations about the updating of stone architecture. He is a visiting professor in several schools of architecture and research associate at the GSA laboratory -Paris Malaquais. Since 2005 he has carried out experiments in stereotomy with the creation of construction stone elements. Some examples: Escalier Ridolfi, an entry portal for the Venice Biennale (a variation of the Abeille vault), Alexandros obelisk, pre-stressed stone arch built in Brignoles, Toulon (France), arch leaf in Parabita, Lecce (Italy), free-standing stereotomic wall hangings, etc.

Federico Fallavollita, Architect, is associate professor at the Department of Architecture of University of Bologna. In 2008 he obtained a PhD in Sciences of Representation and Survey at the Department of History, Design and Restoration of Architecture at Sapienza University of Rome with a thesis entitled: Ruled Surfaces and Developable Surfaces, a Reading through the Virtual Laboratory. He deals with the issues of representation and survey of architecture. In particular, he is interested in renewal of descriptive geometry through informatics tools. He has participated in many seminars and international conferences presenting several memoirs, including The extension of the Problem of Apollonius in space and L'Ecole Polytechnique (in Ikhnos, 2008) and The construction of the main axes of quadric surfaces (in Disegnare, 2013). Currently he is involved in the research team coordinated by Marco Gaiani on the implementation of computer tools for the study and visualization of architecture at the Department of Architecture in Bologna.

Marco Filippucci (Rome, 29 June 1979) graduated in Civil Engineering at the University of Perugia. Phd in Representation and Survey of Architecture and Environment at the "Sapienza" University of Rome awarded in 2012 by UID Italian Union of Drawing. He is author of several papers and since 2006, he is collaborating with the University of Perugia, mainly dealing with the issues of representation, survey and analysis of architecture.

Pablo Álvarez Funes is an architect graduated in 2008 from University of Seville with a Master in Theory, History and Architectural Composition from the Polytechnic University of Madrid in 2013. He is Currently working in London at Stanhopegate Architecture. He is a founding member of INTBAU Spain, which he is representative at its International College of Chapters and on whose activities he regularly participates. In addition he is writing his doctoral thesis on geometry and composition in Islamic architecture under the direction of Javier Cenicacelaya.

Mariateresa Galizia is researcher at the Department of Civil Engineering and Architecture, University of Catania. In 1995 she earned her Degree in Architecture at the Faculty of Architecture, University of Palermo. In 2001 has got her PhD in "Drawing and Heritage Building Survey" (SSD ICAR17), University of Rome La Sapienza. Since 2001 she has been Professor in Drawing of Architecture I and Drawing of Architecture II. Since 2000 is included in group Scientific Research Project of University Research. Since 2003 is included in the national scientific research groups: PRIN. From 1997 she collaborates to research in Surveying and the Representation of the architectural heritage and she works at the Laboratory of Photogrammetry and Architectural Survey "Andreozzi L.", by applications of new technologies to instrumental survey. Since 1997 the research activity, aimed at deepening the themes and content dealing with Drawing and Survey, has been carried out according to the following fields: - Architectural and archaeological survey through integrated and current methods - direct, instrumental, photogrammetric, laser-scanner 3D. - Graphical analysis of architecture as a method to understand the genesis of the forms- Survey of historic urban texture and studies of historical and present maps, as an phase of analytical knowledge of the city, and basic graphics for a basic model of sustainable development in the city. - Representation of territory and environment - as it changes depending on the time and the social, cultural and economic - from the morphology of the territory to architecture that characterizes the identity of places, using innovative software in information technology field. - The multimedia archive, as a tool to understand, management and protection of the Cultural Heritage.

José Teodoro Garfella graduated at Universidad Politécnica of Valencia (Spain) in Technical Architecture in 1991, Master in heritage conservation in 2008, Architect Degree in 2010 and Technical Architecture Degree in 2013. From 2000 he works as Technical Architect and Architect in municipality of Vilarreal and as a public servant since 2001. He works also since 2005 at Universitat Jaume I of Castellón, Spain in the Department of Industrial Systems Engineering and Design at the Bachelor's Degree in Technical Architecture and at Bachelor's Degree in Agrifood and Rural Engineering. Author of more than 30 scientific publications in journals and at international conferences on architectural heritage and graphics uprisings. Member of the research group Architectural Heritage study and "PYDEC -Landscape design and collective spaces and architectural study group of heritage" at the University Jaume I, he has participated in the research project "Methodologies and techniques applied to architectural research of Mediterranean Gothic" and "Case study Groined vaults in the Valencian Gothic: Virtual recreation from geometric-constructive study for dissemination in communication networks" (2011-14). He has

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Nuccio Delfo Giuffrida is a scholar of Architectural History, he collaborates with the group of Architectural Representation at the Department of Civil Engineering and Architecture, University of Catania. In 1996 he has got his degree in Architecture at Milan Polytechnic, in 2007 a PhD degree in Theory and History of Representation at University of Catania; he is now attending classes for a further degree in History of Art. He was lecturer at courses for teachers on Byzantine and Norman-arab architecture in Sicily at Syracuse Superintendence of Cultural Heritage (Syracuse 2010); lecturer at seminar Dal mare alla montagna, percorsi medioevali fra Siracusa e l'entroterra (Syracuse 2013). His research interests are focused on: history of Art; history of Architecture; architectural survey; representation of cultural heritage (3D acquisition and reality based modeling, 3D modeling reconstruction, reverse modeling); graphical analysis of architecture. He is author of: Uno studio sulla chiesa dei Padri Somaschi di Guarino Guarini attraverso le tavole XXIX e XXX del suo trattato (2007); Philip Johnson: una analisi delle tematiche della sua produzione critica (2014).

José Carlos Palacios Gonzalo, Senior Lecturer in the Escuela Técnica Superior de Arquitectura de Madrid. Universidad Politécnica de Madrid. Education: - 1977: Architect by the Escuela Técnica Superior de Arquitectura de Madrid (ETSAM). - 1988: PhD granted by the ETSAM. "Cum Laudae" - 1990: Certificat de Hautes Études de Conservation du Patrimoine. Katholieke Universiteit. Leuven. Belgique. "Grande Distinction" - Educational awards: - 2009: Award to the "INNOVATION TEACHING" of the Universidad Politécnica de Madrid by the course "Workshop on Gothic Construction". - Teaching Experience: - Teaching at the Construction and Technology in Architecture department since 1980. Tenured since 1989. - VISITING PROFESSOR Katholieke Universiteit Leuven, Belgique Centre d'Etudes pour la Conservation du Patrimoine R. Lemaire. Lessons: Stéréotomie. 1989-2002 5 Books. Selected publications: - 2002: "Trazas y Cortes de Cantería en el Renacimiento Español" (2ª Edición). Munilla-Lería.Madrid. ISBN: 84-89150-60-5. - 2009: "La cantería medieval, la construcción de la bóveda gótica española". Munilla-Lería. Madrid. ISBN: 978-84-89150-84-3 15 Books in collaboration, Selected publications: - 2013 "Le scale a pietra a vista nel mediterraneo". Giuseppe Antila, María Mercedes Bares. Edizioni Caracol. Contribución: "Las escaledras de piedra en el tratado de Alonso de Vandelvira" . Impartida en el marco de: Giornata di studi: le scale in pietra a vista nel Mediterraneo. Ragusa. Sicilia. Italia ISBN: 978-88-89440-89-6 - 2014 "Lihic Tree. A search for Natural Steretomy". Press de Ponts et Caussées. Paris 2014. Ed: Fallacara G. Calabria C. Contribución: "The Sexpartite Vault in the Architectur School of Madrid" ISBN:978-2-85978-484-3 Over 24 Papers in Congress, Selected publications: - 2013 Paper: "La estereotomía islámica: El Cairo". José Carlos Palacios Gonzalo. Actas del VIII Congreso Internacional de Historia de la Construcción. Madrid. Pp. 803, 811. Vol. II. ISBN: 978-84-9728-476-9 -2014 Paper: « les voutes sexpartites: France, Espagne ». with Rocío Maira Vidal. Deuxième Congrès Francophone d'Histoire de la Construction. Enero 2014. Lyon. Francia Articles: over 12 publications, 6 of them indexed in ISI-WoK. Selected publications: - 2013 " Diseño y construcción de las bóvedas por cruceros en España durante el siglo XVI". En colaboración con Sandra C. Bravo. Revista Informes de la Construcción., Vol 65, Extra 2, 81-94. CSIC. ISSN. 0020-0883. Web page: - 2012. www.bovedasgoticasdecruceria.com.

Gilbert James Gorski, a licensed architect, is the designer for numerous projects, including the World Headquarters for the McDonald's Corporation in Oak Brook, Illinois and the Oceanarium, a major addition the John Shedd Aquarium in Chicago. Gorski has also served as a studio professor at the Illinois Institute of Technology and at The School of the Art Institute in Chicago. He presently holds the James A. and Louise F. Nolen Chair in Architecture as Associate Professor at the University of Notre Dame. In 1987 Mr. Gorski was designated the Burnham Fellow by the Chicago Architectural Club and was awarded a three-month fellowship to the American Academy in Rome. Since 1989 Gorski has headed his own firm specializing in design and illustration. The American Institute of Architects awarded Gorski a National Award for Collaborative Achievement. In 1990, and again in 2002, the American Society of Architectural Illustrators awarded Gorski the nation's highest singular honor in architectural illustration, the Hugh Ferriss Memorial Prize. Gorski is the author of Hybrid Drawing Techniques: Design, Process and Presentation, Routledge, 2015, and is the coauthor of The Roman Forum, A Reconstruction and Architectural Guide, Cambridge University Press, 2015.

Jaume Gual graduated at Universitsat Jaume I (Spain) in Engineering in Industrial Design Degree in 1999 and at Universitat Oberta de Catalunya, Spain in Bachelor's Degree in Humanities in 2008, Master Degree in Interior Design at Universidad de Salamanca, Spain in 1997 and PhD in Design for collective use and accessibility in architectural heritage at Universitat Politècnica de Catalunya in 2013. He works at Universitat Jaume I of Castellón, Spain in the Department of Industrial Systems Engineering and Design at the Bachelor's Degree in Industrial Design and Product Development Engineering. Author of more than 50 scientific publications in books, books chapters, journals and at international conferences on inclusive design and heritage accessibility. Member of the research group Architectural Heritage study at the University Jaume I, she has participated in the research projects "Methodologies and techniques applied to architectural research of Mediterranean Gothic" and "Case study Groined vaults in the Valencian Gothic: Virtual recreation from geometric-constructive study for dissemination in communication networks"(2011-14). She has participated in Research Scholarship in other universities and institutions: Istituto Europeo di Design at Milano, Universitat Politècnica de Valencia and Universitat Politècnica de Catalunya at Barcelona . Management and participation in educational improvement projects at Univeritat Jaume I. Awards: first prize at the competition "Premios proyectos fin de carrera en materia de accesibilidad al medio físico 2007" Generalitat Valenciana, second prize in the research competition "VI Premio de Investigación". Universitat Jaume I 2005 and first prize at the creativity competition "VI Premi d'Innovació i Creativitat. Cátedra Increa. 2008". He has participated in several art exhibition.

Stefania Iurilli is an architect and PhD, specialized in Survey and Representation of The Architecture and Environment. She graduated in architecture in 2005 at the University of Florence. She is interested in the issues of the digital survey and advanced representation, participating in various survey campaigns and placing particular interest on the themes of treatment and post-production of the digital data. She took part in seminars and international conferences on the theme of digital representation, and on the same topics she published several essays and articles. Her doctoral dissertation was awarded the "Research Prize Città di Firenze" (Florence, 2014) and the "UID Silver Plaque" (Lerici, 2011). She is currently an adjunct professor of Descriptive Geometry and Techniques of Advanced Representation at the University of Ferrara.

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Fernando T. Lima, PhD candidate in Urbanism at Universidade Federal do Rio de Janeiro (PROURB), researching the possibilities of applying parametric resources towards sustainable urban design. Has Master's degree in Civil Engineering from Universidade Federal Fluminense (2008). Professor of Architecture and Urbanism at Universidade Federal de Juiz de Fora, Brazil.

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Omar A. Mures holds a BSc in Computer Science and a MSc in High Performance Computing from the University of A Coruña (Spain), where he works as predoctoral research associate since 2012. His main research interests include Computer Vision and Computer Graphics.

Manalee Sunil Nanavati is a graduate from Faculty of Architecture, CEPT University, Ahmedabad, India. Along with her experience in architectural practices, she has efficiently worked as a teaching assistant for several design studios at CEPT University after her graduation in 2012. Her work has chiefly focused on the area of organizational structures, elements and language formation, multidisciplinary design approaches, and socio-spatial dialects. At present Manalee is pursuing her masters in the area of Architectural Regeneration and Development at Oxford Brookes University, Oxford, UK as a Hodgkinson scholar. This chapter is based on Manalee's undergraduate dissertation titled as 'Understanding the Phenomenon of Repetition in Architecture', carried out in the academic year 2010-11. This dissertation was conferred upon the gold medal award for 'Best Research' in 2012 by GICEA.

Luigi Nasini graduated in Agricultural Sciences in April 2000 at the University of Perugia and in 2001 he entered the Order of Doctors of Agronomy Forestry of the province of Perugia. In 2001 he received his Master (organized by the Region of Umbria) in stabilization and conservation of historic centers in unstable territories and in January 2004 he received the title of Doctor of Philosophy in Arboriculture and Plant Protection. Since 2005 carries out post-doctoral research in the field of arboriculture in the Department of Agricultural and Environmental Science, University of Perugia, as a contractor, fellow and research fellow. In the academic year 2011/2012 has earned 60 credits, by successfully completing the Master International Olive and olive oil extraction. The research activity is documented by 67 scientific papers published in proceedings of conferences, national and international journals and books, addressing the following issues:-physiological aspects related to production processes, with reference light interception, the ratio source / sink and heat stress conditions, water and shade, depending on the quality and quantity of fruit production and olive;-efficiency improvement of cropping systems, with reference to the influence of cultural practices on fruit-bearing cycle and acquisition character quality of fruit production and olive - fruit ripening, mechanical harvesting and quality in olive oil, olive mill waste-disposal on agricultural land;-composting of organic matrices for the production of high quality compost. He worked as organization and coordination within the international research projects, national and regional. He is co-advisor of 20 Theses, a PhD thesis and 4 Master's thesis in Olive and olive oil extraction. Good knowledge of the English language.

Ubaldo Occhinegro, born in Taranto on 12/02/1984, is an Architect and PhD in "Architectural Design for the Mediterranean Countries" at Polytechnic School of Bari - DICAR (Department of sciences of Civil Engineering and Architecture). Currently is visiting professor in "Architectural Drawing and Representation" at Polytechnic School of Bari. At the same faculties, he has several lectures at the courses "History of Architecture, Architectural Tipology, Theory of Architecture. He partecipates, as a lecturer and tutor, at numerous national and international workshops and stage on the theme of contruction and design in traditional Architecture. He focuses his research interests on the issues of planning, architectural design and restoration and is the author of several essays and monographs on the subject of 'historic architecture in Mediterranean Areas and, in particular in Puglia, analizing morpho-typological features in Swabian architecture and studing urban tissue of different Mediterranean cities. He is author of several national and international publications on diverse aspects of design and construction related

to the historical mediterranean architecture and Stereotomic and traditional techniques in stone architecture His architectural drawings are featured in various publications and awards. With Claudio D'Amato Guerrieri he partecipates at the exhibition "The Italian Architecture for the City of China", exposed to Shanghai - Expo 2010 . Alongside the academic activity he supports an intense work in architectural design, restoration and rehabilitation of monuments.

Emilio J. Padrón's main activity is doing research (and teaching) as an Assistant Professor (Tenure Track) member of the Computer Architecture Group at University of A Coruña (Spain). He is mainly interested (and involved) in two different fields, mostly in the intersection of them: High Performance Computing (HPC) and Computer Graphics (CG). His HPC research is focused on Parallel and concurrent processing, GPGPU, Heterogeneous (hybrid) systems and Big data; whereas his CG expertise is mainly in Global illumination for Physically-based rendering (ray tracing, radiosity), Surface subdivision, Point-based rendering, Level of detail (LOD) and Real-time rendering.

Rodrigo Cury Paraizo is a researcher in the field of the digital representation of architecture and the city, especially urban heritage. Graduated in Architecture, he got his PhD from the Post-Graduate Program of Urbanism at the Faculty of Architecture of the Federal University of Rio de Janeiro (PROURB-FAU-UFRJ), where he is currently Adjunct Professor. He is a member of the Laboratory of Urban Analysis and Digital Representation (LAURD-PROURB), where he worked in several digital heritage projects developing interactive applications and cultural objects databases.

Davide Pellis is a Ph.D. student at the Department of Civil and Environmental Engineering of University of Florence, graduated in Building Engineering. His research topic deals with Geometry and Computational Design, Structural optimization, Architectural Geometry and Parametric Design.

Eliana Manuel Pinho has a PhD in Mathematics (University of Porto) and has developed this work as a post-doctoral researcher in the Faculty of Architecture, University of Porto (grant SFRH/BPD/61266/2009 from FCT). Eliana worked in the areas of patterns, symmetry, coupled cell networks, geometry in Roman architecture, and the teaching of descriptive geometry, and is interested in the subjects shared by art/architecture and mathematics.

Janice de Freitas Pires is assistant professor at the Faculty of Architecture and Urbanism at the Federal University of Pelotas, in Graphic and Digital Geometry courses for undergraduate and graduate and currently a doctoral student at the Federal University of Santa Catarina, Brazil. Acting in the Study Group for Teaching / Learning Digital Graphic - GEGRADI, graduated in Architecture and Urbanism, Specialization in Digital Graphic and Master of Architecture and Urban Planning at the same university. She has experience in Architectural Graphic Expression and Education, with emphasis on teaching / learning of Digital Graphic Representation for classroom education and distance, devoting himself mainly to the following topics: geometry, shape grammar, learning objects, geometric modeling.

Claudia Pisu graduated in Civil Engineering (2003) and Ph.D. in Civil Engineering (2009) at Cagliari University. She had an institutional research grant (S.S.D. 08/E1, 2009-2013) from the University of Cagliari, Department of Architecture, in the Scientific Area: Civil Engineering and Architecture, (S.S.E. 08/E1). Expert in the field of the Disciplinary Scientific Sector 08/E1 (Drawing) at the Faculty

of Architecture of Cagliari University (Since 2009), and at the Faculty of Architecture of Alghero (Since 2011). She has been professor of drawing in the Faculty of Architecture and Engineering of Cagliari. Her research interests are drawing of architecture and graphic documentation of cultural heritage. She is the author of some publications in the field of Drawing and Cultural Heritage.

Beniamino Polimeni received his Master Degree from the School of Architecture of the "Università Mediterranea" of Reggio Calabria in 2004. Since 2007 he has been cooperating with several architecture firms participating in European and International design competitions. In 2008 he won the Italian Prize for digital architecture, promoted by "National Association of Young Architects", on exhibition in the XXII UIA World Congress of Architecture in Torino. In 2010 he received his PhD in "Scienze della rappresentazione e del rilievo". In 2012 he was a post-doctoral fellow in the Aga Khan program for Islamic architecture at MIT. He is currently assistant professor of architecture at Abdullah Gül Üniversity.

Francesca Porfiri was born in 1984; she is Architect since 2010; since 2010 she is providing Teaching Assistance in many survey and representation's academic courses. On July 2014 she graduated Ph.D. in Representation and Survey Sciences, at Sapienza University of Rome. In September 2014 her Ph.D. thesis won the UID mention "Gaspare De Fiore" award. She has attended several workshops and seminars on survey, architectural representation and descriptive geometry. She made several publications and speeches in national and international conferences.

Primo Proietti graduated in Agricultural Science in 1984 with full marks and honours. 1988 PhD graduation. 1990-2002 Researcher and 2002-present Associate Professor for "General Arboriculture and Tree Cultivation" (AGR/03) in the University of Perugia. In 2013 eligibility to become Full professor. Responsible for numerous National and European research projects. Research activity, documented by more than 280 papers, published in international and national journals and books; concerns: ecophysiology and efficiency of fruit tree species; use of olive-oil by-products; CO_2 sequestration in olive groves; buffer strips; olive landscape, etc. He is referee for international scientific journals and research projects and Co-Editor in chief of "Global Journal of Advanced Biological Sciences" and Editorial Board Member of "Journal of Biotechnology Research". He obtained several scientific awards. Since 1990 Lecturer in several courses in the University of Perugia and Malta. Membership of Accademia dei Georgofili, ISHS, SOI, Accademia Nazionale dell'Olivo e dell'Olio, etc.

Andrea Quartara is a PhD student at the Department of Science for Architecture of the Genova Polytechnic School. He enrolled in the graduate program in Architecture in Genova, in 2007. The core of his M. Arch thesis - [in]forming form. Generation and mutations of an urban algorithm, developed with Giulio Dini - was the design of an algorithmic structure which allows the management of a data stream of varying and different natures. In July 2013 they submitted the thesis with honours. In January 2014 Andrea became a Licensed Architect. At the same time he started his PhD grant. In March 2014, he became a member of EmergentaGE group. He organized and co-tutored Grasshopper® and Maya® software-based workshops: they were goal-oriented to 3D print. In September 2014, he organized with the group ICAR65 an international symposium – FormafterForm On the relentless emergence of new (architectural) forms.

Juan R. Rabuñal, PhD in Computer Science (year 2002), and PhD in Civil Engineering (year 2008). Associate professor in computer Science School of University of A Coruña (Spain) since 2000.

Luca Regni was born in 19th december 1987 in Perugia. In 2011 he got his degree in agricultural sciences. In 2012 he worked in a seed multiplication company. In 2013 he took a research grant with Department of Agricultural and Environmental Science. In December 2013 he started my PhD with Department of Agriculture, Food and Environmental Sciences. His research topics are: carbon sequestration in agricultural and forestry systems, valorisation of mills waste and other by-products of food chains, role of buffer zones in reducing the pollution load (nitrates and agrochemicals), role of selenium in the reduction of water stress in the vines and in the olive, production of oil and wine enriched in selenium, salt stress in olive (physiological and genetic mechanism involved in the resistance).

Ehsan Reza: Education *2000-2003 Sooreh university(Architecture High Diploma) *2005-2008 Eastern Mediterranean University (Bachelor degree) *2009-present Eastern Mediterranean University (Bachelor degree) .Experiences *2001 Naghshe Jahan .co (for summer training)- Model making *2002-2003 Joharies Brothers office (project control) *2004-2006 Architectural Office (control project, Working drawing) *2008 Particiration in work shop with M.I.T *2008-present Research assistant in the architectural faculty of E.M.U.

Cettina Santagati is Assistant Professor of Architectural Representation at the Department of Civil Engineering and Architecture, University of Catania and head of the "Section of Innovative technologies for survey and 3D reconstruction applied to Cultural Heritage and Smart Cities" at the research center IEMEST in Palermo. She has got her degree with honors in Building Engineering at University of Catania (1997). In 2003 she got her PhD degree in "Drawing and Survey of building heritage" from the University of Rome "La Sapienza". Since 2012 she has served as reviewer for several international scientific journals and international conferences and for international projects (horizon 2020). Her research interest are focused on: Urban, Architectural and archaeological survey; analysis and experimentation of innovative methodologies and techniques aimed at the knowledge and the representation of cultural heritage (3D acquisition and reality based modeling, 3D modeling reconstruction, reverse modeling); graphical analysis of architecture; Descriptive Geometry. She is author and co-author of 80 scientific publications (books, book chapters, article in Journals and International proceedings) for the most part presented at International Conferences.

Giovanna Spadafora, Architect, PhD in Drawing and Survey of building heritage, is Associate Professor of Drawing at the Department of Architecture - Università di Roma Tre, where she teaches Descriptive Geometry and Survey. She teaches archeological and architectural survey in the International Postgraduate Course in Architectural Restoration. She is member of the PhD Scientific committee in Architecture, Innovation and Heritage, a consortium doctorate of Università di Roma Tre (Department of Architecture) and Politecnico di Bari (Department of Architecture). Her research interests are focused on surveying and documentation of archaeological and architectural heritage.

José Antonio Franco Taboada, Professor at the Polytechnic Universities of Valencia and Santiago de Compostela, he was the first Director of the Technical School of Architecture of A Coruña and its Department of Architectural Representation and Theory. Author of publications, conference speeches,

master's courses, doctorates, seminars and talks at international congresses. Member, from 1989 to 1995, of the Governing Council of the E.A.A.E. (European Association for Architectural Education), with its headquarters in Brussels. Among other merits we can mention the awarding of the Targa d'Oro (Gold plaque) from the U.I.D. (Unione Italiana per il Disegno) in 2004. He is Emeritus Professor at the University of A Coruña.

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