

International Conference
FACES of GEOMETRY
from Agnesi to Mirzakhani

Aula Magna Edificio 1- Rettorato
Politecnico di Milano



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Ore 9.00 - Piazza Leonardo da Vinci, 32
Milano

ABSTRACTS

**International Conference
Faces of Geometry. From Agnesi to Mirzakhani**

ABSTRACTS

The reasons of International Conference Faces of Geometry. From Agnesi to Mirzakhani

History gives many examples of women who have distinguished themselves in art, science, literature and medicine. They are almost always stories of struggles and commitment that deserve to be remembered. Maria Gaetana Agnesi (18th century), author of the first book in Italian dedicated to teaching mathematics, and Maryam Mirzakhani (20th century), the first woman to win the Fields Medal for research in Geometry and Dynamical Systems, have made the difference. For this reasons, we decided to organize an international conference in order to enhance the scientific contribution of women and the geometric study that are still the object of a cultural preconception. Geometry and its applications, both analogical and digital, have great importance in our research and education activities and curriculum, constitute our basic operating language and support our semantics. The **International Conference Faces of Geometry. From Agnesi to Mirzakhani** aims to promote interdisciplinary discussions and links between theoretical research and practical studies on the various faces of geometry and its applications in architecture, art, design, education, engineering, mathematics. These fields of research can enrich one another and renew the common interests of the various disciplines, promoting female participation. Furthermore, the conference aims to provide an exchange of views and comparison to identify new areas of research and increase the quality of teaching.

P.Magnaghi-Delfino, G.Mele, T.Norando

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Maria Teresa BARTOLI

Università degli Studi di Firenze

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Abstract

Unexpected geometries exploring the design of the Gothic city

Geometry and architecture have always collaborated in the project, experimenting in the second the achievements of the first. In every age great mathematicians have worked alongside the great architects, although we do not always have direct information about them. History has recognized this relationship in many cases where the literary tradition provided news for its evidence: Pyramids, Greek temples, the Pantheon, the architecture of Humanism etc. Can historical research discover less evident forms of this relationship by working exclusively with geometry, in examples where the literary tradition has not directly given the news? The research was focused on the design of the gothic city, which historiography relates by finding in the past the characters considered necessary for the development of the subsequent history rather than the objective requirements linked to the knowledge and intentions of the historical moment. The study of Florence urban design in the Gothic era was addressed to two themes: the layout of the walls and the distribution of Great Convents. The conclusions reached can give a lot of information about the relationship between the geometric culture diffused at the time of the works we are dealing with, the scientific treatises and the culture transmitted by the social, historical and poetic literature. All these research areas can be extended and integrated, giving a more complete and truthful image of the mindset of the time.

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Federico Alberto BRUNETTI

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Abstract

Geometry and shape, drawing and design; observation, deciphering, modelling

Geometry accompanies the knowledge of space and places both intuitively and through cultural education.

Some innate elements are the base of the instantaneous perception and processes of visual recognition of forms. Moreover, the theoretical teaching and the practical activities allow to structure visual and tactile and knowledge of primary geometric shapes, as well as the capacity for the mental modelling of space. Following a similar procedure for the design of the Design Laboratory, analogue and digital modelling methods are coherently explored through the assigned project. The results of two case studies recently concluded are presented here finalized for the composition of elementary geometric elements: the construction of reticular architectural structures and the radio centric enquiry of vegetal elements. The aim of these experiences concerns the possibility of experimenting visual understanding, on the basis of drawing, modelled in analogue way by hand and then verified through digital procedures by means of modelling and rendering software. These specific training courses took place within the framework of the new training methods defined in Italy in the recent Alternanza Scuola Lavoro guidelines (here in collaboration with Parco Nord Milano and the Accademia Fondazione Fiera Milano), where the training focusing on soft skills is integrated with the learning in specific and ordinary didactic disciplines.

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Giorgio BURATTI

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Abstract

Computational Process and Code-Form definition in Design

In design process drawing has always preceded the construction phase. The act of drawing, based on basic geometric elements such as lines, curves, surfaces and solid, allows to organize one's ideas, manage resources and predict results. In recent years, the increased level of digital literacy has led to a new kind of draw generated through the creation of algorithms. Form is not a priori defined, but it is consequence of a discrete rules set resulting from a refinement process of conceptual, communicative, structural and geometric instances, leading to the outcome that best meets the project hypotheses. This approach requires the adoption of theoretical analysis and understanding tools capable of managing a high level of complexity. In an age where the digital model can directly inform a machine able to manufacture it, the role of geometry is fundamental not only in understanding reality, but also in controlling the act of shaping matter. The paper analyses some experiences in design field where form is described and constructed by computational process.

Franca CALIÒ, Elena MARCHETTI

Politecnico di Milano, Mathematics Dept.

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Abstract

To observe, to deduce, to reconstruct, to know

(A method of teaching Geometry in Architecture and Design courses)

This paper deals with a didactic experience gained in courses that are part of the first year of studies for the Schools of Architecture and Design of the Politecnico di Milano. One of the themes of these courses concerns geometric problems, in order to introduce students to 3D space. The peculiarity of the didactic method used is, first, to induce the student to observe the real object by identifying its geometric characteristics (symmetries, proportions, contours, and surfaces enveloping it). Subsequently, the goal is to teach how to translate the observed form into mathematical language and to draw it on the computer, using a suitable tool of Computer Graphics. The method, consequently, allows deepening and appreciating, with greater awareness, the characteristics of the studied form. To illustrate the process, we will present applications related to significant and fascinating objects of interest for the public we are addressing.

Cristina CANDITO

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Abstract

The role of geometry in the architecture of Louis Kahn and Anne Tyng

Among the salient features of the architecture of Louis I. Kahn (1901-1974), one recognizes the ability to reconcile the aesthetics of Modernism with monumentality and one of the means used to implement this programmatic attitude is geometry. In this regard, we cite the projects for the Trenton Bath House (1955-56) and the unrealized Philadelphia City Tower (1952-57), which, for various reasons, are today attributed in the geometric conception to Kahn's collaborator, Anne Griswold Tyng (1920-2011). Graduated from Harvard in 1944, Tyng shows her predisposition for a wise application of pure geometric principles and her specific contribution to Kahn's works, her companion until 1960, was brought to light thanks to the publication of their correspondence (Louis Kahn to Anne Tyng, 1997). Here it is also interesting her reflection exhibited in an essay (From Muse to Heroine. Toward a Visible Creative Identity, 1989), in which she illustrates different stories of women who, although endowed with great skills, were able to play the only function of inspiring muses for men who have become famous. Tyng expresses in the most appropriate form - the geometry of the graphics inserted at the end of the text - her theory about the evolution of the woman's role towards an autonomous creative expression.

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Alessandra CAPANNA

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Abstract

Thinking architecture in four dimensions

In mathematics it is quite easy to define four dimensional geometry. With their equations, in fact, mathematicians work without any difficulty with any "n" dimension. From this point of view it is also quite easy to describe what shape in our 3d world a hypercube, for example, can assume, taking advantage of projections of the geometric figure in the lower dimension. We have to say that architects are accustomed to draw the space they imagine through orthogonal projections and therefore to see the 3d space through its 2d projection in plan and section.

Moreover the perception of the physical space in architecture is experiential. It means that although the sense of sight is able to capture the geometric, figurative and aesthetic characters, ultimately the harmony of the shapes, the quality of the built environment is perceived with all the senses, in a dynamic approach, as a continuous sequence of space-events in so demonstrating the consistency of architecture space-time 4d reality.

As part of a research on the design theory and related analysis of the compositional process, as well as related changings of paradigms in Architecture, the paper presents as well the geometric consistency of multidimensional characteristics of Steven Holl's porous space, of Zaha Hadid's works - who graduated in mathematics before her graduation in Architecture - passing through numerous examples of architectures in which the concept and the image of multi-dimensional geometry interpret the architectural thought of the XXI century.

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Lorella CARIMALI

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Excerpt of the book

La radice quadrata della vita

I am carrying on a battle for the enhancement of the School, the teachers and Mathematics as a way of thinking and a way of dealing with life, making it clear that there are no people hopeless at this discipline.

Mathematics could really change the World and could be a social liberation.

To get this message, I wrote a novel *La radice quadrata della vita* (The Square Root of Life), which Rizzoli will publish on Tuesday, 18th September 2018. The novel is dedicated to teachers, to the friendship, to tolerance, to young people, to Mathematics and to the School.

This is the plot:

If life gives you problems, "numbers" could be the solution!

Donatella firmly believes so when, freshly graduated in Mathematics, she chooses to dedicate herself to teaching. It is the Seventies; for love, she left Milano moving to Catania. The encounter with the school is disruptive. Donatella, certain that the right answer is never the one you have in your pocket, is an unconventional teacher: she explains to her pupils - who see only rules - that Mathematics is also creativity and that a plan could be a spherical surface, if only you are able to change the perspective.

Comprehending Mathematics is like comprehending a piece of art; it takes a lot of imagination

and free spirit.

Forty years later, one-step from retirement, Donatella has another special encounter, which will remain in her heart forever: she meets Blanca, a young Italian and Latin teacher at her first supply, who will be teaching at the same high school of Donatella, with eyes full of hope and concern. The students will look at her as she looked at her substitute teachers when she was a student too: it is her very first challenge and she has no idea how to deal with it. However, she will not be alone in this adventure; Donatella will be her new traveling companion, in and out of the school. Divided by her Iranian father's traditions and her own desires, Blanca will find in Donatella the most experienced colleague and a guide who will lead her into the unknown world of numbers, where she will learn to deal with emotions and discover the square root of her happiness.

Giuseppe CONTI, Raffaella PAOLETTI

Università degli Studi di Firenze

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Abstract

Reuleaux triangle in Architecture and Applications

The Reuleaux triangle is a figure with the remarkable property of having constant amplitude, a typical property of the circle. It takes its name from Franz Reuleaux, a 19th century German engineer, who studied its properties, in particular the ones related to applications to mechanics. However, this figure was previously known: actually, we find it in the shape of the windows and in the ornaments of some Gothic architecture. Furthermore, Leonardo da Vinci, to represent the terrestrial globe, used eight triangles of Reuleaux, each one corresponding to an octant of the spherical surface. Even the mathematician Euler encountered this figure in his study of geometric forms with constant amplitude. The Reuleaux triangle has numerous applications also in modern architecture, in jewelry design, in simple objects of everyday life, in the brands of different companies, in the shape of coins, in the mechanics of rotary engines and some cinema projectors, in the form of some water valve covers and road signs. Furthermore, it is able to generate curious mechanisms.

Chiara de FABRITIIS

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Abstract

Interplays of geometry and music: how to use geometry to analyze an artwork in order to compose a musical piece

This paper, which summarizes a collaboration with D. Amodio (Conservatorio Benedetto Marcello, Venezia), describes how geometric techniques can be used to analyze an artwork and to obtain parameters employed for the composition of a musical score; in particular these approach was applied to a painting by Jackson Pollock and a poem by Giacomo Leopardi. In the first case, the initial task is the study of the graphic structure of the canvas, looking for forms and their spatial organization; this work is followed by the choice of the mathematical techniques used to examine the different classes of objects previously singled out; the last step is the computation of the parameters which will be used by the composer to orchestrate the score. In the second case, the starting point is the analysis of the phonetic structure of the poem, looking for consonances; then a combinatoric approach is used in order to create a representation of the idyll as a plane graph to highlight the permutations of some group of letters; a second image of the poem as a cylindrical helix is used to measure time distances in the occurrence of syllables; again, the parameters obtained by these computations are used for the draft of the music.

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Biagio DI CARLO

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Abstract

Adventures in the realm of triangles

In their simplest and most elementary form, the structures used in design science are the three-dimensional version of the planar interlacing (biaxial and triaxial) that has always been used for the construction of gratings, baskets and textures. The reciprocal frames can be considered as a premise to the tensegrity structures, which in turn can be considered as a premise to the geodesic structures. Geodesic structures arise from the correct subdivision of polyhedral shapes. The nascent reciprocal joint as a simple, natural and economic form, can be reworked towards the starred joint where the rods contribute towards a single junction point. The structural stability of natural structures is guaranteed by the presence of the triangle. A triangulated structure, optimized for use, does not require additional materials to ensure its resistance.

Paolo DULIO

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Abstract

How to climb a vector space

In several contexts, including teaching, the obtained results are sometimes influenced by aspects that, apparently, shouldn't have any correlation with what is proposed. In particular, an extremely rigorous lecture on mathematical subjects could reflect in a tedious show for the audience in case no intuitive visualization is provided. Indeed, in my opinion, the presentation of highly technical topics would benefit from ludic and playful insights, possibly touching on daily reality.

As an example taken from my teaching in the course of Geometry and Linear Algebra, I propose the definition and construction of a vector space in terms of a mountain climbing in an adventurous country.

Sylvie DUVERNOY

Politecnico di Milano, Dept. Design
ITALY



Excerpt of the book

The Little Prince's Universe

In the original tale by Saint-Exupéry, while traveling through the universe, stopping from planet to planet, the Little Prince meets a few grown-up persons, but not the Turkish Astronomer who was able to see from the Earth the small planet from which he comes: asteroid B-612.

In his book, *The Little Prince's Universe*, Francesco Palla reports an imaginary conversation between the two of them, during which the Little Prince asks the Turkish Astronomer to tell him about the many wonders and mysteries of the universe. From mythological constellations, to nebulas, comets, asteroids, pulsars and black holes... all the various fields of modern scientific research in astrophysics are addressed. Fields in which new discoveries and progresses are made every day.

The representation of the geometry of the universe makes use of the same projection techniques that produce Earth's geographic maps. But when the sky is represented as a 3D solid celestial globe, the constellations, seen from "above", are mirrored respect to the natural view of the Earth's inhabitants. Many ancient star atlases and catalogues show those reflected images. The illustrations in this book display an anthropomorphic view of the constellations. And also, since the book is meant for a young readership, the monstrous aspect of some mythological animals that was popular in the previous centuries, has been smoothed.

Indeed, Francesco Palla dedicates his story to youngsters, from whom he expects the answer to the great mystery of the universe: the true nature of the "dark matter" which constitutes 90 % of the cosmos matter and which "is invisible to the eye".

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Kay Bea JONES

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Abstract

**Caterina Marcenaro + Franco Albini.
For the Love of Art**

If architecture is a collaboration between volumes and voids, with materials, climate, geography, and forces of gravity, then the creative process most significantly depends upon the collaboration between the client and her architect. The story of the relationship between Caterina Marcenaro and Franco Albini, for whom he designed four museums and her personal apartment, is a story of mutual respect and innovative intentions to modernize the way Italians engage in their historic patrimony. In the immediate aftermath of World War II, Genoa was a city in ruin, yet possessed extraordinary church and private art collections that required intervention. Marcenaro and Albini provided intelligent curation, skillful lighting, and public access. Their timely realization of progressive concepts that strike a balance between expressions of tradition and principles of modern interpretation established a legacy that defines this era of Italian museology.

Barbara MESSINA

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ITALY

Abstract

Women and Descriptive Geometry in Italian Universities

This paper aims to analyze the women's contribution to the teaching of Descriptive Geometry in the Italian Faculty of Architecture and Engineering.

Starting from the analysis of current data collected by ministerial archives and by retrieving, back in time, further information, such as the sources of the Italian Association of Drawing Professors (Italian Drawing Union-UID), the paper proposes a diachronic reading that can illustrate, in general, the role of the teaching by women in the specific scientific-disciplinary field ICAR 17/Disegno. An area of interest in which many different cultures coexist. In particular, we draw attention to Descriptive Geometry, firstly highlighting – through appropriate graphs that re-elaborate the acquired data – the contribution, the position and the incidence of the female figure in the field. Then, focusing on some key figures for the university teaching evolution of this discipline, we intend to honor those who have distinguished themselves, by leaving a mark both in the didactic and in the scientific field.

Sibel Yasemin ÖZGAN, Mine ÖZKAR

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Abstract

The Dividing of the Sphere in Domes of Medieval Anatolia

The stylistic language of art and architecture in medieval Anatolia largely consists of geometric features. The geometric patterns embrace various levels of mathematical complexity. Whereas the two-dimensional graphic design involves certain geometric relations and rules, their making, in three-dimensional space, relies on more than visual transformations, and mainly on the spatial material qualities and the overall architectural form. For a rightful implementation that ensures the architectonic harmony, it is crucial to consider various parameters along the geometric design, such as the surface geometry, the physical properties of the material, and the crafting technique. Under the patronage of Seljuks in Anatolia, the application of the decoration program on historical buildings in a precise manner manifests a collaboration coordinated by a master builder between mathematicians, designers, and craftsmen. Geometric patterns were applied to all kind of building surfaces but dome decorations particularly addressed challenges of building on the form of the spherical geometry. We investigate various historical strategies for constructing holistic patterns on dome surfaces and how each handles the aspects of geometrical calculation, the design and construction processes simultaneously.

Michela ROSSI

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ITALY

Abstract

The shape between organic model and design

The historical treatises pursued the search for a rule in geometric laws that envisage the relationship between numbers and forms, fixing the articulation and the measure of architecture. Despite an inevitable inertia, architectural research always showed in formal and structural canons the concepts expressed by geometry, which like any science evolves in an attempt to explain increasingly complex facts, as the man's ability to observe the nature's world progresses. New geometries coincide with new space-structural conceptions that refer to inspirational models, which are based on the commitment of nature: on one hand it asks questions to explain, on the other hand it offers solutions to design problems.

The reference to the nature is a constant explaining the strong relationship between geometry and design. It finds a scientific reason in the perfect efficiency of biological equilibria, which men imitated first in the external forms of ornament, then in balance of structures, and finally in the orderly control of chaos.

Anna SALVADORI

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ITALY

Abstract

Inverse formulas: from elementary geometry to differential calculus

The inverse problem (of a formula, a function, a matrix, an operator) is one of the most delicate topics in mathematics education. It appears apparently in various forms, at different levels of the school path.

My contribution presents an innovative didactic proposal aimed at highlighting the unifying element of the problem, by a path in continuity from Secondary School of the first degree to the basic courses of the University.

Emanuela UGHI

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ITALY

Abstract

A concrete approach to geometry

A concrete approach to geometry is barely accepted in primary school, but is not usually used and proposed in higher school levels. I present some examples to show how the activity of touching, building, manipulating mathematical objects can stimulate thoughts, observations and questions that are not at all elementary, at every level.

Mária ŽDÍMALOVÁ

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ITALY

NOTE

Abstract

Tessellations and Patterns

In this contribution we discuss tessellations and patterns. We analyze basic tessellations, types of tessellations, geometric approach and applications of tessellations in geometry as well as in architecture and art. We study as well as groups of tessellations used in Spanish Alhambra. Finally we open possibilities how to use tessellations for aggregations, aggregations functions and aggregate tessellations. We discuss how we can use weighted Voronoi diagram for tessellations and we consider as well weighted Voronoi tessellations.

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